THE RELATIONSHIP BETWEEN FINANCIAL PERFORMANCE AND SAFETY IN THE AVIATION INDUSTRY: A WORLDWIDE PERSPECTIVE

SIZHE XU

A Thesis

In

The John Molson School of Business

Presented in Partial Fulfillment of the Requirements

For the Degree of Master of Science in Administration (Finance) at

Concordia University

Montreal, Quebec, Canada

April 2015

CONCORDIA UNIVERSITY
School of Graduate Studies

This is to certify that the thesis prepared

By: Sizhe Xu

Entitled: **The relationship between financial performance and safety in the aviation industry: A worldwide perspective**

and submitted in partial fulfillment of the requirements for the degree of

Master of Science in Administration (Finance)

complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the final examining committee:

Dr. Caroline Roux ______________________ Chair

Dr. Juliane Proelss ______________________ Examiner

Dr. Denis Schweizer ______________________ Examiner

Dr. Thomas Walker ______________________ Supervisor

Approved by Dr. Harjeet S. Bhabra ______________________

Chair of Department or Graduate Program Director

Dr. Steve Harvey ______________________

Dean of Faculty

Date April 10, 2015 ______________________

ABSTRACT

The relationship between financial performance and safety in the aviation industry: A worldwide perspective

Sizhe Xu

The year 2014 turned out to be a significant one for the global airline industry. The missing Malaysia Airlines flight MH370, the shooting down of Malaysia Airlines flight MH17, the disappearance of Air Algérie flight AH5017 and most recently the crash of Air Asia flight QZ8501 have raised great concerns about airline safety. In this paper, we investigate whether financial factors influence an airline's maintenance, purchasing, and training policies, and ultimately its safety performance. Using global data from 110 airlines in 26 countries over the period 1990 to 2009, we find an inverse relationship between profitability of air carriers and their accident propensity. Other financial variables such as liquidity, asset utilization, and financial leverage do not appear to affect an airline's safety record. Moreover, we find that the legal and economic environment of a given country has a significant effect on airline safety. Specifically, airlines in countries with strong law enforcement, more stringent legal regulations, and better economic performance have better safety performance.

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to my supervisor, Dr. Thomas Walker. He has given me the continuous guidance and support throughout my MSc thesis. I would like to thank him for his patience, kindness, enthusiasm, and immense knowledge. His efforts and encouragement helped me through my research. Without him, this thesis would not have been completed or written. I could not imagine having a better supervisor for my MSc thesis. I will fondly remember my time as his student throughout my life.

I would also like to take the opportunity to thank my committee members, Dr. Juliane Proelss and Dr. Denis Schweizer, who gave me very important advice and helped me improve this thesis.

Last but not least, I must thank my loving parents. Without their selfless dedication, I could never have gotten to where I am today.

TABLE OF CONTENTS

1. Introduction

Although it is well known that flying is one of the safest modes of transportation, aviation accidents do inevitably happen and the consequences are often devastating both in terms of human fatalities and damages to the aircraft and on the ground, and indirectly through their impact on consumer confidence.

Based on statistics by the National Transportation Safety Board (NTSB), the number of accidents of U.S. scheduled airlines per million miles flown ranged between 0.0026 and 0.0073 from 1990 to 2009, reaching its lowest point in 2008. According to the Aviation Safety Network, in 2014, there were 692 fatalities across the globe on civil aircraft with a minimum capacity of 14 passengers[1]. While disconcerting, that figure is less than the average of 832 people who died annually in aircraft accidents during the prior decade. A recent survey conducted by TheStreet estimates that one of every three adult Americans have some degree of anxiety about flying internationally[2]. Given the public's fear of flying, it is not surprising that academics have developed an interest in determining the possible factors that may affect a crash, so that better regulations can be implemented to prevent or mitigate such mishaps. Specifically, the impact of financial pressures on the safety standards and accident track records of airlines has been a long-standing public concern, particularly in countries with laxer governmental controls. However, there has been little empirical research on this issue, making the resolution of this debate an attractive area for financial researchers.

Early studies on the relation between an airline's financial health and its safety record have typically used short time series and small cross-sectional data sets on U.S. airlines and found no evidence that airlines in poor financial health forego the necessary safety, training and

[1] "Despite high profile accidents, 2014 was the safest year ever according to ASN data", the Aviation Safety Network, January 01, 2015, Harro Ranter, http://news.aviation-safety.net/2015/01/01/despite-high-profile-accidents-2014-was-the-safest-year-ever-according-to-asn-data.
[2] "1 in 3 Americans Fears International Travel and Flights, Poll Shows", TheStreet, July 31, 2014, Ted Reed, http://www.thestreet.com/story/12827707/1/1-in-3-americans-fears-international-travel-and-flights-poll-shows.html.

maintenance investments and thereby compromise on flight safety (see Sobin and Armore, 1980; Golbe, 1986; Kanafani and Keeler, 1989; and Adrangi et al., 1997). Studies using more extensive data sets and safety measures document that lower profitability is correlated with higher accident and incident rates, particularly for smaller carriers (Evans, 1989; and Rose, 1990). However, the rarity of airline accidents, together with their small sample size, produces a common drawback. The potential power of their statistical tests is restricted (Rose, 1990). A comprehensive sample is therefore needed to obtain more accurate results. Furthermore, due to deregulations in most countries, the industry has grown even more competitive. In the course of technology development, some air carriers have pursued profits at the expense of safety investments, such as reduced maintenance expenditures and pilot training. Finally, there is no study to date that explores the impact of an airline's financial performance and governmental regulations on airline safety in a cross-country context. Our study aims to close this gap in the literature.

Our study makes major contributions of both a theoretical and applied nature. First, there has been little research that examined the relation between an airline's financial condition and its safety performance. In addition, the small sample size of earlier studies often imposed a limiting factor. We hope to overcome these problems by employing a comprehensive data set that covers aviation accidents and financial performance data for airlines around the globe since 1990. Second, our study will be the first to perform a cross country analysis in which we control for and examine the impact of governmental regulations and other country factors on aviation safety. Our results should be of interest both to academics and to regulators who develop, oversee, and implement policies targeted at improving aviation safety on a national and supranational level. If the financial condition of airlines is an important factor that affects aviation safety, the International Civil Aviation Organization (ICAO), the Federal Aviation Authority (FAA), and other regulatory authorities should consider allocating more resources to the supervision of financially weak airlines (Noronha and Singal, 2004). Moreover, the results of this study will be important for air carriers and airline passengers who are undoubtedly concerned about their safety.

On a firm level, our results are consistent with prior studies, which suggest that lower profitability is correlated with higher accident rates while variations in airlines' asset utilization or financial leverage do not significantly affect their accident propensity. Moreover, on a country level, we find a significant relationship between governmental regulations and air carrier safety. The coefficients on our country variables (efficiency of the judicial system, rule of law, and corruption) are negative and highly significant.

The remainder of this paper is organized as follows. In Section 2, we review the related literature. Section 3 presents detailed information for our data set, while our hypotheses and methodology are discussed in Section 4. Empirical results are provided in Section 5, followed by conclusions in Section 6.

2. Literature review

2.1 The aviation industry – A glimpse

Before examining the relationship between financial performance and safety in the aviation industry, it is important to gain some insights about the industry itself. Before 1970, the airline industry was mainly influenced by technological innovations, aircraft manufacturing, and flight condition improvement. It was not until the 1970s that aircraft technology became mature enough for air travel to be a common transportation method for people worldwide. It is also worth mentioning that during the late 1970s, the industry experienced one of the most prosperous times of its existence, primarily due to the deregulation, which first took place in the U.S. and soon spread to most other industrialized countries. By minimizing governmental intervention in air carriers' commercial decisions about pricing, routes, and capacity, the 'Open- Skies' policy permitted the liberalization of rules and provided a free-market environment to the airline industry (Debbage, 1994; and Cento, 2008). As a result, many new carriers entered the market and increased competition within the industry, which some argue led to a reduction in maintenance standards. However, there is no proof (in the form of statistical evidence) that shows a decrease in airline safety during that time (Belobaba et al., 2009).

In the beginning of the 21st century mankind witnessed the most astonishing misfortune in aviation history: the terrorist attacks of September 11. The attacks generated enormous fear of air travel and constituted an exogenous demand shock, which took the industry 17 months to overcome (in terms of the capacity reduction) and recover to its pre-disaster state (Cento, 2008). Although the U.S. government offered generous financial assistance to the industry, several airlines applied for bankruptcy protection. Moreover, the 2002 SARS outbreak, combined with the 2003 Iraq war, caused a second demand shock. As recorded by Cento (2008), passenger travel demand decreased by about 36 percent (30 percent) following the September 11 terrorist attacks (the SARS outbreak), respectively. During those years, the industry appeared to undergo the most difficult period ever.

Stricter security measures at airports and advancements in technology greatly contributed to passengers restoring their confidence in air travel; in addition, the rise of Low Cost Carriers (LCC) injected new energy into the tight global aviation industry and allowed the industry to experience an increase in passenger demand (Berry et al., 2007). However, the growth phase ended, as the economic crisis broke out in 2008, resulting in the largest revenue decline and capacity reduction since 9/11. Hence, allocating airport resources properly and organizing seat capacity and flight connectivity became important determinants for airlines to generate significant air traffic during the economic crisis (Dobruszkes et al., 2011). Morrell (2011) also observes that, in the context of the recession, the industry implemented many changes in order to cut costs and share risks such as reducing fares, eliminating old aircraft, downsizing, and implementing corporate strategies such as mergers and acquisitions. Overall, the airline industry is a very sensitive industry that is highly susceptible to external shocks, the global economic environment, and political turmoil (Morrell, 2011; Franke et al., 2011). Therefore, it is important that we consider the macro-economic environment in our analysis.

2.2 Aviation accidents

Although travel by airline is generally accepted as one of the safest forms of transportation (Oster et al., 2013), accidents occasionally do happen. However, not all phases of a flight are at equal risk of an accident, and safety concerns vary from stage to stage. Figure 1 offers an overview of the percentage of accidents that occurred in each flight phase between 1959 and 2008. The figure shows that the landing phase is most dangerous, as 36 percent of all fatal accidents happened during that phase. Second comes the takeoff stage, where the proportion of fatal accidents is as high as 20 percent. The cruising and descent phase are least risky, accounting for 8 percent and 4 percent of fatal accidents, respectively. The information gained from these statistics is important in directing approaches to improve aviation safety.

*** Insert Figure 1 about here ***

In addition to understanding when accidents are most likely to occur, it is also important to understand why they occur. We identify four major causes of accidents: (1) human error, (2) mechanical failures, (3) weather, and (4) criminal activities.

*** Insert Table 1 about here ***

Table 1 provides information on the causes of fatal accidents that occurred worldwide from 1950 to 2010 based on data provided by the PlaneCrashInfo accident database. Accidents involving aircraft with 18 or fewer passengers aboard, military aircraft, private aircraft and helicopters are excluded. Admittedly, not all accidents have a single cause. In fact, they may be caused by a series of events, mistakes, and failures, which relate directly to one another. Hence, we classify aviation accidents using the most prominent cause. Table 1 shows that pilot error was by far the most frequent culprit, accounting for 53 percent of accidents. Our results are consistent with Wiegmann et al. (2001) and Shappell et al. (2004) who also identified pilot error as the most prominent cause of aircraft accidents. Pilot errors can be attributed to a range of organizational influences, including deficient supervision, inappropriate planning of flights, inadequate training (Johnson et al., 2003), willful violations of rules, and corruption to bypass regulatory oversight (Wiegmann et al., 2001). The second most frequent cause in Table 2 are mechanical failures, accounting for nearly 20 percent of accidents. Prior academic studies (Sexton et al., 2000; Baker et al., 2001; and Wiegmann et al., 2001) show that ground crews' lack of experience, aircraft manufacturers' miscalculation, and pilot mishandling are the main reasons for mechanical failure. The third important cause of aircraft accidents are weather conditions, including wind, poor visibility and turbulences (Knecht et al., 2010). However, some of these weather-related accidents may have been avoided if the flight crew was properly trained to cope with certain weather conditions. Training, experience, and equipment are crucial in order to successfully overcome dangerous meteorological situations (Knecht et al., 2010). Criminal activities include explosive devices, shoot-downs, and hijackings. The events of September 11, 2001, when 2,996 people were killed and Malaysia Airlines flight MH 17, which was shot down on July 17, 2014, and led to the death of 283 passengers and 15 crew members are among the most prominent cases in this category.

2.3 Accidents and airline finances

Several prior papers have examined the relation between an airline's finances and its safety record. Many critics have argued that airlines sacrifice safety investments in a strive for higher profits, especially during times of increasing competition in the airline industry (Lee, 1996, and Roland, 1997). They argue that financial constraints might cause air carriers to reduce maintenance and training expenses and to keep outdated airplanes in service. However, most prior studies find little or no evidence for a link between an airline's financial and safety performance (Graham and Bowes, 1979; Golbe, 1986). Despite the increase in global and local competition in the airline industry, many of these studies point out that it is crucial for airlines to put safety concerns ahead of economic interests and maintain consumer confidence.

Rose (1990) explores the relation between airline profitability and safety performance. She finds that a 7.6% increase in the operating margin of individual carriers is associated with a 7.4% decrease in the airline's accident rate. The logic underlying her findings is the belief that airlines make their decisions on safety investments by evaluating their needs to raise the air traffic safety level in terms of the cost of additional safety-enhancing investments and the benefits of reducing their accident risk, which includes lower insurance premiums, lower wages, and higher airfares. In contrast, airlines that under-invest in safety will suffer penalties from airline passengers, employees, and insurance companies. Therefore, if the management of an airline believes that the benefits derived from additional safety-enhancing investments are lower than the costs of under-investing in safety, they may choose to reduce their safety investments to the lowest level possible under regulatory guidelines. In addition, if airlines face financial distress, they may allocate less money, manpower, and material resources to safety-enhancing projects, particularly if they feel that the chance of an accident is low. Moreover, Rose performs a detailed data analysis and notes that the effect is more pronounced for small and medium sized carriers but is not statistically significant for larger airlines. Her results are supported by Doinne et al. (1997) who also find a negative relationship between financial health and airline safety, using a sample of Canadian airlines. Doinne et al. argue that prior results that find no statistical significance may be biased by how safety performance is measured, i.e. by looking at fatal accidents which are quite rare and are not a perfect measure of safety. Hence they include accidents involving bodily injury or damages into their analysis and report an inverse relationship between financial performance and accident rates. In a study of how debt financing affects a firm's product quality, Maksimovic and Titman (1991) point out that when facing financial difficulties, highly leveraged firms are more likely to sacrifice their product quality compared to unlevered firms in the same industry. If we assume that safety is part of an airline's product quality, then in line with Maksimovic and Titman, the capital structure of an airline should affect its safety record.

Recent studies that examine the relationship between profitability and air carrier safety generally find mixed results. Raghavan and Rhoades (2005) study the U.S. airline industry after its deregulation using accident rates as a measure of safety. Their results are consistent with Rose (1989,1990), that is, there is a negative relationship between financial performance and accident rates among air carriers, especially among smaller regional carriers. Noronha and Singal (2004) employ a different approach to determine whether there is a link between an airline's finances and its safety record. They adopt bond ratings as a proxy for financial health instead of using profitability. They report that airlines with higher bond ratings tend to have fewer accidents than those with lower bond ratings. Phillips and Sertsios (2013) interpret an airline's safety record as a reflection of its product quality. They study a sample of 21 U.S. airlines from 1997 to 2008 and find that when firms in the airline industry are under financial distress, they sacrifice their product quality (i.e. their safety) in order to regain profitability. However, Wang et al. (2013) analyze a sample of 28 U.S. airlines from 1991 to 2008 and find no statistically significant relationship between an airline's financial condition and its safety performance. In summary, the empirical evidence on whether an airline's financial health has an impact on its safety record is still mixed, making the question of how to improve aviation still a matter of great concern.

3. Data

In our study, we plan to provide evidence not only from a North American viewpoint, but also from a global perspective. Our sample for this study consists of 110 airlines from 26 countries during the period 1990 to 2009. Due to the entry and exit of several air carriers during that timeframe and due to missing data, we have to work with an unbalanced data set. If an airline was never involved in an accident but otherwise had all available data for this study, it is reflected in our sample with an accident frequency of zero. Appendix A lists all airlines and years covered in our data set. Appendix B lists all major accidents that these airlines experienced and that either resulted in a loss of human life or a write-down of the aircraft.

As noted above, we investigate airlines from 26 countries. While our sample selection is driven by the usual data availability limitations, it covers airlines from a variety of geographic locations, with distinct variations in economic strength and population. As such, it should provide a good reflection of the global aviation industry. The 26 countries in our sample are distributed in the developed, the developing, and the least developed world. Figure 2 depicts the geographical regions represented in our sample[3].

*** Insert Figure 2 about here ***

We collect data on global aviation disasters from the National Transportation Safety Board (NTSB) and two online databases: aviation-safety.net and planecrashinfo.com. To ensure the accuracy and reliability of these databases, we compare every detail of overlapping records among the databases, and also checked Wikipedia, where information about most airline accidents and incidents is recorded and accessible. We did not find any spurious data problems

[3] Specifically, these countries include: Argentina, Austria, Brazil, Canada, Chile, Colombia, Ecuador, France, Germany, India, Italy, Japan, Kenya, Malaysia, Mexico, Netherlands, Pakistan, Portugal, Singapore, South Korea, Spain, Switzerland, Thailand, Turkey, the U.K., and the U.S.

during these cross-checks. As Rose (1989) points out, using airline accident rates as a proxy for safety is more appropriate for studies whose purpose is to investigate air carrier safety rather than air system safety, as most accidents occur due to the air carrier's fault, such as pilot error, lack of experience, inadequate training and aircraft maintenance problems while the causes of incidents can be mainly attributed to air traffic control systems and natural elements, instead of air carrier related factors. Hence, to allow for a comparison of our results to most prior studies in this area, we restrict our sample to accidents (i.e. cases involving fatalities, serious injuries, or substantial aircraft damage)[4], and eliminate accidents caused by illegal acts (hijacking, sabotage, shoot down) and wildlife hits, as those accidents are not the airline's fault. We also exclude flights that carry less than 18 passengers. These criteria help us focus on influential accidents in our analysis. Table 2 outlines the distribution of aviation accidents among our sample countries.

*** Insert Table 2 about here ***

To evaluate the financial condition of our sample airlines prior to an accident, we use data on air carrier finances from the International Civil Aviation Organization (ICAO), which can be found in its database module "M3: Air Carrier Finances". In line with Flouris and Walker (2005), we retrieve information on each airline's current assets, current liabilities, sales, total assets, total liabilities, net income, and stockholder's equity to calculate our financial variables, which we define and explain in the next section.

4. Methodology

Our study aims to examine whether airlines have poorer safety performance and are more prone to accidents when they experience financial difficulties. Specifically, we hypothesize that: (1) If financial factors such as profitability, liquidity, or leverage influence an airline's purchasing and training policies, these variables will account for differences in airline safety performance after controlling for other relevant factors. (2) Airlines in countries with laxer legal regulation, worse

[4] NTSB defines an accident as "an occurrence associated with the operation of an aircraft that takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage" http://www.ntsb.gov/Pages/Report.aspx, assessed March 4, 2015.

law enforcement, and poorer economic performance are likely to have poorer safety performance.

Because it is difficult to accurately quantify safety performance due to a lack of airline capacity data (e.g. passenger kilometers or seat kilometers flown, or the number of takeoffs and landings), we introduce a novel proxy, which differs from prior studies that explain the safety performance of an airline. Specifically, we argue that, ceteris paribus, the total number of accidents for each airline depends on the airline's number of flights and total air miles flown. We further argue that these two factors are closely associated with the air carrier's operating revenue, which is typically derived from the transport of passengers and baggage. For an airline, the expenditures on fuel, maintenance, service, and crew salaries plus fixed costs such as insurance and airport charges are often highly variable, thus the airline's operational decisions are to a large extent determined by trading off these costs against the airline's operating revenues. Generally, airlines achieve a certain level of revenue passenger kilometers by adjusting the number of flights on each route and the turnaround times of those flights. We measure an airline's accident rate by dividing the number of accidents it experiences during a given time frame by its operating revenues during that period: $\frac{Accidents}{OperatingRevenue}$. Specifically, we consider a four year time span as the observation window for this paper, because a medium-to-long term observation window is often considered as a practical method to view the economic activities for an airline from disaster relief to recovery, thus the ratio is ultimately defined as: the number of accidents of an airline during a four year period/the operating revenues of the airline over that four year period[5].

We consider four categories of financial ratios that are most frequently used to evaluate a firm's performance and financial health in our estimations: (1) The *current ratio*, as Liquidity proxy. The current ratio is a balance sheet ratio that is traditionally used in finance to measure the ability of a firm to pay off its short-term debt obligations with its short-term assets. It provides information about the efficiency of a firm's operating cycle as well as the possibility of a firm running into liquidity problems. It is generally considered an indicator of bad financial health when the current ratio is too low. (2) The *debt ratio*, as a measure of financial leverage. The debt

[5] Each variable is calculated over four years to smooth out random fluctuations.

ratio is an extensively used financial ratio that indicates the firm's ability to pay off its debt in the long run. The ratio represents the proportion of assets that are financed by debt, and helps investors and creditors evaluate the debt burden of a company and its risk of insolvency. The higher the ratio, the more leveraged is the firm. (3) *Total asset turnover*, as an activity ratio. Total asset turnover is an important index that measures how efficiently and effectively a firm uses its assets. The higher the total asset turnover ratio, the greater the productivity of the firm's assets derived from either more efficient operations or increased sales demand. Hence, we expect that a lower asset turnover ratio is associated with poorer safety performance. (4), (5), and (6) are *profitability ratios* which aim to capture an airline's current and expected future profitability. (4) *The net profit margin* measures the percentage of revenue remaining to shareholders after all operating expenses, interest, and taxes have been paid. As such, a firm's net interest margin evaluates whether a company is good at converting revenue into profit attributable to shareholders. (5) *Return on assets* (*ROA)*, a measure of overall earning power or profitability, is expressed as a percentage of profit that a company earns in relation to its overall resources. It provides an indication of how efficient a business is in using its assets to generate net income. (6) *Return on equity* (*ROE)* measures how much profit a company earns in relation to the total amount of shareholder equity on its balance sheet. The higher the ratio, the better the firm is at pursuing shareholder wealth maximization.

Because airline operations are influenced by the regulatory and macro-economic environment in a given country, we consider a series of country variables that measure, among other things, the country's economic strength, the regulatory/legal framework in the country, and whether the country is politically stable. We argue that the accident propensity of airlines in countries with high political instability increases due to a lack of consistent regulatory polices. In this paper, we employ five country variables to account for the external influence of different country-level factors on airline safety: (1) The *gross domestic product (GDP) per capita* sheds light on the country's economic well-being and economic growth. Because it is obtained by dividing a country's gross domestic product by the number of people in the country, it represents the relative economic performance of the country and is especially useful when making comparisons between countries. (2) *Registered carrier departures (Departures)* capture the number of domestic and international takeoffs of air carriers registered in the country and reflect the air transportation usage in the country. We argue that the more developed the air transport sector in a given country (relative to its GDP), the stronger is the regulatory oversight of the aviation sector. (3) A country's *unemployment rate* is widely recognized as a key indicator of the country's economic well-being. It reflects how well the government is using its authority to ensure that jobs are being offered to those who need them. In addition, following La Porta et al. (1998), we consider (4) the *efficiency of the judicial system*, (5) the *rule of law*, and (6) *corruption* to describe differences in the institutional environment across countries. These measures are scored from zero to ten; with lower scores representing a lower quality institutional environment of a country. In addition, we employ a dummy variable, i.e. (7) a *common law dummy* to identify whether the legal system of a given country originates from English common law. The variable equals one if the origin is English common law, and zero otherwise. A vast literature points out that common law countries have better institutions and policies than countries with legal systems that originate from civil law. For example, common law countries grant more freedom to the entry of new businesses (Djankov et al. 2002). They provide a better quality of contract enforcement, stronger protection of private property (Djankov et al. 2003), and a more developed financial system (La Porta et al. 1997, Djankov et al. 2008) with less corruption (Treisman 2000).

Our empirical analysis employs a series of ordinary least squares regressions designed to assess the impact of an airline's financial condition and a country's macro-economic environment on airline accident risk. Specifically, as noted above, we use the following internal and external explanatory variables: the current ratio, the debt ratio, total asset turnover, the net profit margin, ROA, ROE, GDP per capita, departures, the efficiency of the judicial system, the rule of law, corruption, the unemployment rate, and the common law dummy. Table 3 provides an overview of our explanatory variables.

*** Insert Table 3 about here ***

Using these measures, we examine whether an airline's accident propensity can be explained by factors that describe the airline's financial health during the preceding period as well as the regulatory and economic environment of the country in which the airline primarily operates.

We thus estimate the following model:

$$\frac{N(Accidents)}{OperatingRevenue} = \beta_0 + \beta_1 Liquidity + \beta_2 Leverage + \beta_3 Activity + \beta_4 Profitablity$$
$$+\beta_5 ln(GDPperCapita) + \beta_6 ln(Departures) + \beta_7 Unemployment + \beta_8 LegalVariables + \varepsilon$$

Our main focus is on the first four variables that proxy for the financial condition of an airline. Using ordinary least squares (OLS) regressions, we estimate the above equation using an airline's 4-year accident frequency to proxy for the airline's safety performance. Raghavan and Rhoades (2005) use OLS regressions to examine the link between the financial performance of airlines and the airlines' safety performance post deregulation and find a significant negative relationship between these variables, but only for small regional carriers. We follow their approach and expect to find a similarly negative relationship between an airline's financial condition and its safety performance.

5. Empirical results

Our first hypothesis argues that financial factors influence an airline's maintenance, purchasing, and training policies and thereby its safety performance. To test this hypothesis, we examine whether our six financial proxies can explain differences in airline safety performance after controlling for other relevant factors. Before running our tests, Table 4 provides descriptive statistics for our data set.

*** Insert Table 4 about here ***

Our second hypothesis proposes that airlines in countries with laxer legal regulations, worse law enforcement, and poorer economic performance have poorer safety performance. We focus on the aforementioned macroeconomic and institutional variables. Table 5 lists all countries in our sample by GDP rank (2012) and shows the country-level variables for each country.

*** Insert Table 5 about here ***

Before we estimate our regressions, we compute Pearson correlation coefficients between each variable pair. The corresponding correlation matrix is provided in Table 6. We observe a high correlation between a country's GDP, corruption index, and rule of law (with correlation coefficients >0.8). To avoid any multicollinearity problems in our subsequent regression models, we include those three variables separately. In addition, we employ our profitability proxies (net profit margin, ROA, and ROE) in separate models to examine whether results are sensitive to the use of different predictors.

*** Insert Table 6 about here ***

Table 7 reports the results of our regression analyses. In all regressions, the dependent variable is accident frequency during a four-year period. Specifically, the first column shows the results of our basic model. We first focus on the interpretation of variables related to an airline's financial condition. As shown in Models 1 and 2 of Table 7 Panel A, the estimated parameters for net profit margin and ROA are negative and significant, indicating that higher profitability of an airline is associated with a lower accident rate. If an airline's net profit margin (ROA) increases by 10%, it leads to a decline of 19.26% (16.15%) in its accident frequency. The variables that measure an airline's liquidity, asset turnover, and financial leverage, have negative but statistically insignificant coefficients. Moreover, the results for ROE in column 3 of Panel A, which also serves as a profitability indicator, are not statistically meaningful. It is possibly due to the major difference between ROE and ROA – debt. However, for the airline industry whose capital demand is great, assessing the impact of ROA on the financial performance of a company is more convincing than using ROE. With respect to the macroeconomic environment, we find that the coefficient for Ln(GDP) significantly negatively relates to accident frequency. The coefficient of Ln(GDP) in our base model is -0.3055 with a p-value of 0.0001, indicating that airlines in countries with higher GDP per capita have better safety performance. One possible explanation for this result is that developed or industrialized countries have stricter safety regulations; hence airports and air traffic control personnel have to fulfill stricter standards. Next, we estimate different variations of our basic model to control for any multicollinearity between highly correlated variables and to examine how each country variable affects aviation safety when viewed alone. The results are highlighted in Table 7, Panel B. The second column of Panel

B reports a regression with only Ln(GDP) as our country-level explanatory variable. The results basically replicate the first model of Table 7. We again find that countries with higher GDP per capita perform significantly better than countries with lower GDP per capita, suggesting that differences in economic strength may affect safety performance across countries. Column 3 of Panel B provides results for a regression with only Ln(Depatures) as our country-level explanatory variable. In this model, we find that the coefficient of Ln(Departures) becomes negative and significant, suggesting that the more domestic and international takeoffs by air carriers registered in the country, the lower the accident propensity of airlines in that country. A common sense interpretation for this finding is that the higher the air transportation usage in a country, the more concerned the country is about its aviation infrastructure including, for instance, its air traffic control system and its aviation safety system, hence the risk of airline disasters is controlled to some extent. Panel B, columns 4-8 replicate the first three columns by adding country-level variables for the legal and economic environment. As predicted, the coefficients for these legal variables (the efficiency of the judicial system, the rule of law, and corruption) are negative and highly significant. This supports our second hypothesis that airlines in countries with laxer legal regulations, worse law enforcement, and poorer economic performance are likely to have poorer safety performance. The unemployment rate of a country has almost no influence on an airline's safety performance, with a coefficient that is roughly zero and insignificant.

*** Insert Table 7 about here ***

Finally, in order to avoid any distorting effects that extreme values may have on our results, we perform a robustness test in which we winsorize our data at the 5th and 95th percentile in terms of our six firm-level financial variables. Our outcomes are little affected by this winsorization except for ROE, which becomes statistically significant at the 10% significance level (see Table 8). Overall, our results suggest that higher profitability for an airline is associated with a decrease in its accident rate. Our results also provide evidence that airline accidents display endemicity, that is airlines in countries with laxer legal regulations, worse law enforcement, and poorer economic performance tend to have poorer safety performance.

*** Insert Table 8 about here ***

Next, we carry out an alternative test to investigate whether there is a relationship between a firm's financial performance and its safety performance. We introduce a commonly used measurement, Altman's Z-score (Z score), which was originally proposed by Altman (1968) to determine a firm's financial health. The higher the score, the lower the probability of business failure for a company. In his initial tests, Altman (1968) showed that the Z-score is 72% accurate in predicting the probability that a firm will head for bankruptcy within two years. In a series of follow up tests, he established an 80-90% accuracy of Altman's Z-score in bankruptcy prediction with a Type II error (predicting the firm to go bankrupt although it does not) of approximately 15–20% (Altman, 2000). In addition, Altman (2001) devises an alternative formula that can be applied to non-manufacturing firms and can be expressed as follows: Z=6.56*X1+3.26*X2, +6.72*X3+1.05*X4, where X1 is working capital/total assets; X2 is retained earnings/total assets; X3 is earnings before interest and taxes/total assets; and X4 denotes the book value of equity/total liabilities. The Z-score measure has been commonly used in the academic literature to evaluate an airline's financial condition (e.g., Vasigh et al., 2010; and Wang et al., 2013).

In line with our hypothesis, we expect that financial distress affects an airline's willingness and ability to invest in maintenance, purchasing, and training and thereby harms its safety performance. Thus, we expect an inverse relationship between our financial variable (Altman's Z-score) and an airline's accident frequency. The results of our analysis, as detailed in Table 9, show that the Z score coefficients have negative signs as expected in all models. However, the results are insignificant. Significant results are confirmed for the relationship between accident frequency and Ln(GDP), the efficiency of the judicial system, the rule of law, and corruption with p-values of 0.0043, 0.0469, 0.0131, and 0.0056 in Models 2,4,5, and 6, respectively.

*** Insert Table 8 about here ***

In summary, we observe that country-level factors explain variations in accident propensity quite well. In addition, although there is no uniform effect of all our variables that measure an airline's financial health on safety performance, our study shows that an airline's profitability relates significantly to accident propensity. Specifically, our findings suggest a significant negative relationship between the profitability of an airline and its accident risk. Moreover, as noted above, the legal and economic environments of a given country also have a significant effect on airline safety.

6. Conclusions

The purpose of our study is to answer the question whether airlines have poorer safety performance and are more prone to accidents when they experience financial difficulties. We regress the accident frequency on six firm-level financial variables and seven country-level variables during our sample from 1990 to 2009 and find a negative relationship between profitability and accident rate. Those airlines that have kept profitability down have a higher risk profile. This is consistent with our common-sense notion that an unprofitable or insolvent airline may reduce its safety investments by flying older airplanes (i.e. not upgrading its fleet) or by saving on pilot training and aircraft maintenance. On the other hand, safety performance gets improved as airlines can afford to properly perform maintenance of their aircrafts, training staff, and purchasing new planes. Accordingly, airlines with higher profit aspirations are more willing to be concerned about securing the customers confidence and thus pay more attention to improvement of security and avoidance of accidents.

We further examine whether a country's macroeconomic and institutional environment affect the safety of airlines headquartered in that country. As expected, we find that airlines in countries with stronger law enforcement, more stringent legal regulations, and better economic performance have better safety performance. These findings remain consistent regardless of whether we consider financial ratios or Altman's Z-score to measure the financial performance of an airline.

The unique contribution of our study is that it is the first to explore safety performance drivers on a global basis. We address our research question using extensive data from 110 airlines in 26 countries and by examining the relationship between airlines' financial performance and safety in a cross-country context.

Our results have important policy implications for both the airline industry and regulators. To allocate resources more efficiently, regulators may find it beneficial to focus their supervision on financially weak airlines. Moreover, as noted earlier, pilot errors remain the most frequent cause for aviation accidents. Thus, developing and refining policies that reduce accidents caused by pilot errors should be a prime goal for regulators. Various approaches come to mind to address this problem, such as reducing working hours or adding more shifts in order to avoid pilots being too stressed or too tired, improving the working condition for pilots, and enhancing the supervision of cockpit during cruising.

7. Limitations

Our study does not come without limitations. Most importantly, our study is limited by the unavailability of certain data and the methodology adopted. For example, a more comprehensive measurement of an airline's safety performance using detailed flight data such as takeoffs, landings, and passenger miles flown could not be constructed due to data restrictions. Also, additional control variables that capture, for instance, the landing and takeoff risks at different airports around the world[6] would be desirable and helpful in improving the explanatory power of our model.

Furthermore, future studies could control for cultural differences between countries by adopting, for example Hofstede's "uncertainty dimension"[7]. According to Hofstede's cultural dimension theory, citizens in countries with a high level of uncertainty avoidance are more dependent on

[6] Hong Kong (China) and Lima (Peru), for example, are known as difficult airports for landings/take-offs, thus airlines in these countries may be exposed to higher risk (regardless of their financial condition).
[7] Hofstede examines cultures differ between countries based on six different categories of cultural dimensions. Those dimensions are: power distance, individualism versus collectivism, masculinity versus femininity, uncertainty avoidance, long-term versus short-term orientation, and indulgence versus restraint (cf., Hofstede, 2001, and Hofstede et al., 2010).

structural rules, prefer stability, and more likely to take fewer risks (Hofstede, 2001, and Hofstede et al., 2010).

Lastly, it would be interesting for future studies to employ clustering-adjusted standard errors to account for any possible biases that may arise when using OLS standard errors while estimating panel regressions (Petersen, 2009).

Despite these limitations, we believe that the present study has taken an important step towards a better understanding of the relationship between an airline's financial condition and its safety performance. Exploring other data sources that contain detailed flight data would perhaps be useful to enhance our methodology, and is suggested for future research.

8. References

Adrangi, B., Chow, G., & Raffiee, K. (1997). Airline deregulation, safety, and profitability in the U.S., Transportation Journal, 36(4), 44-52.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. The Journal of Finance, 23(4), 589-609.

Altman, E. I. (2000). Predicting financial distress of companies: Revisiting the Z-score and ZETA models. Working Paper, New York University.

Altman, E. I. (2001). Bankruptcy, credit risk, and high yield junk bonds. Blackwell Publishers, Malden, MA.

Baker, S. P., Lamb, M. W., Grabowski, J. G., Rebok, G., & Li, G. (2001). Characteristics of general aviation crashes involving mature male and female pilots. Aviation, Space, and Environmental Medicine, 72(5), 447-452.

Barnett, A., & Wang, A. (2000). Passenger-mortality risk estimates provide perspectives about airline safety. Flight Safety Digest, 27, 1-12.

Belobaba, P., Odoni, A., & Barnhart, C. (2009). The global airline industry. Hoboken, NJ: John Wiley & Sons.

Botero, J. C., Djankov, S., La Porta, R., López de Silanes, F., & Shleifer, A. (2003). The regulation of labor. SSRN Working Paper No. 408480.

Carter, D. A., & Simkins, B. J. (2004). The market's reaction to unexpected, catastrophic events: The case of airline stock returns and the September 11th attacks. Quarterly Review of Economics and Finance, 44(4), 539-558.

Cento, A. (2008). The airline industry: Challenges in the 21st century. New York, NY: Springer Science & Business Media.

Chi, J., & Baek, J. (2013). Dynamic relationship between air transport demand and economic growth in the United States: A new look. Transport Policy, 29, 257-260.

Debbage, K. G. (1994). The international airline industry: Globalization, regulation and strategic alliances. Journal of Transport Geography, 2(3), 190-203.

Dionne, G., Gagné, R., Gagnon, F., & Vanasse, C. (1997). Debt, moral hazard and airline safety: Empirical evidence. Journal of Econometrics, 79(2), 379-402.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2002). The regulation of entry. Quarterly Journal of Economics, 117(1), 1-37.

Djankov, S., Glaeser, E., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2003). The new comparative economics. Journal of Comparative Economics, 31(4), 595-619.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2008). The law and economics of self-dealing. Journal of Financial Economics, 88(3), 430-465.

Dobruszkes, F., & Van Hamme, G. (2011). The impact of the current economic crisis on the geography of air traffic volumes: An empirical analysis. Journal of Transport Geography, 19(6), 1387-1398.

Evans, W. N. (1989). Deregulation and airline safety: Evidence from count data models. Unpublished manuscript, College Park, MD: University of Maryland.

Flouris, T., & Walker, T. J. (2005). The financial performance of low-cost and full-service airlines in times of crisis. Canadian Journal of Administrative Sciences, 22(1), 3-20.

Franke, M., & John, F. (2011). What comes next after recession? Airline industry scenarios and potential end games. Journal of Air Transport Management, 17(1), 19-26.

Golbe, D. L. (1986). Safety and profits in the airline industry. Journal of Industrial Economics, 34(3), 305-318.

Graham, D. R., & Bowes, M. (1979). Do finances influence airline safety, maintenance, and services? Alexandria, VA: Public Research Institute of the Center for Naval Analyses.

Hofstede, G. H. (2001). Culture's consequences: Comparing values, behaviors, institutions and organizations across nations. Ed. Geert Hofstede. Thousand Oaks, CA: Sage.

Hofstede, G. H., Hofstede, G. J., & Michael, M. (2010). Cultures and organizations: Software of the mind, 3rd ed. New York, NY: McGraw-Hill.

Hosmer, D. & Lemeshow, W. (1989). Applied logistic regressions. Ed. John Wolfley & Sons, 8-20.

Johnson, C., & Holloway, C. (2004). On the over-emphasis of human ‘error’ as a cause of aviation accidents: ‘Systemic failures’ and ‘human error’ in US NTSB and Canadian TSB aviation reports 1996–2003. In: Proceedings of the 22nd International System Safety Conference (ISSC). Providence, RI: Systems Safety Society.

Kanafani, A., & Keeler, T. (1989). New entrants and safety. In: Leon N. Moses and Ian Savage, eds. Transportation Safety in an Age of Deregulation, New York, NY: Oxford University Press.

Knecht, W. R., & Lenz, M. (2010). Causes of general aviation weather-related, non-fatal incidents: Analysis using NASA aviation safety reporting system data. Working paper No. DOT/FAA/AM-10/13). Federal Aviation Administration Oklahoma City, OK: Civil Aeromedical Institute.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1997). Legal determinants of external finance. Journal of Finance, 52, 1131-1150.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. W. (1998). Law and finance. Journal of Political Economy, 106(6), 1113-1154.

Lee, R. (1997). New directions in air safety. Australian Journal of Forensic Sciences, 29(1), 19-28.

Maksimovic, V., & Titman, S. (1991). Financial policy and reputation for product quality. Review of Financial Studies, 4(1), 175-200.

McWilliams, A., & Siegel, D. (1997). Event studies in management research: Theoretical and empirical issues. Academy of Management Journal, 40(3), 626-657.

Morrell, P. (2011). Current challenges in a ‘distressed’ industry. Journal of Air Transport Management, 17(1), 14-18.

Noronha, G., & Singal, V. (2004). Financial health and airline safety. Managerial and Decision Economics, 25(1), 1-16.

Oster, C. V., Strong, J. S., & Zorn, C. K. (2013). Analyzing aviation safety: Problems, challenges, opportunities. Research in Transportation Economics, 43(1), 148-164.

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. Review of Financial Studies, 22(1), 435-480.

Phillips, G., & Sertsios, G. (2013). How do firm financial conditions affect product quality and pricing? Management Science, 59(8), 1764-1782.

Raghavan, S., & Rhoades, D. L. (2005). Revisiting the relationship between profitability and air carrier safety in the US airline industry. Journal of Air Transport Management, 11(4), 283-290.

Reynolds, T. H., & Flores, A. A. (1989). Foreign law: Current sources of codes and basic legislation in jurisdictions of the world. Littleton, CO: FB Rothman.

Rose, N. (1989). Financial influences on airline safety. In: Leon N. Moses and Ian Savage, eds. Transportation Safety in an Age of Deregulation, New York, NY: Oxford University Press.

Rose, N. (1990). Profitability and product quality: Economic determinants of airline safety performance. Journal of Political Economy 98(5), 944-964.

Sexton, J. B., Thomas, E. J., & Helmreich, R. L. (2000). Error, stress, and teamwork in medicine and aviation: Cross sectional surveys. British Medical Journal, 320(7237), 745-749.

Shappell, S. A., & Wiegman, D. A. (2003). A human error analysis of general aviation controlled flight into terrain accidents occurring between 1990-1998. Working Paper No. DOT/FAA/AM-03/4, Federal Aviation Administration Oklahoma City, OK: Civil Aeromedical Institute.

Shappell, S. A., & Wiegmann, D. A. (2004). HFACS analysis of military and civilian aviation accidents: A North American comparison. In: Proceedings of the Annual Meeting of the International Society of Air Safety Investigators.

Sobin, B., & Armore, S.J. (1980). Economic factors in air safety of trunk carriers. Unpublished manuscript. Washington: Office of Economic Analysis, Civil Aeronautics Board.

Treisman, D. (2000). Decentralization and the quality of government. Working paper, UCLA.

Vasigh, B., Fleming, K., & Mackay, L. (2010). Foundations of airline finance: Methodology and practice. Farnham, England: Ashgate Publishing, Ltd..

Walker, T. J., Thiengtham, D. J., & Lin, M. Y. (2005). On the performance of airlines and airplane manufacturers following aviation disasters. Canadian Journal of Administrative Sciences, 22(1), 21-34.

Wang, Z., Hofer, C., & Dresner, M. E. (2013). Financial condition, safety investment and accident propensity in the US airline industry: A structural analysis. Logistics and Transportation Review, 49(1), 24-32.

Wiegmann, D. A., & Shappell, S. A. (2001). Human error analysis of commercial aviation accidents: Application of the Human Factors Analysis and Classification System (HFACS). Aviation, Space, and Environmental Medicine, 72(11), 1006-1016.

Figure 1: Fatal Accidents and On Board Fatalities by Phase of Flight (1959 through 2008)

This figure provides an overview of the percentage of fatal accidents and onboard fatalities that occurred in each flight phase over fifty years (1959-2008). The figure shows that the landing phase is most dangerous. After the landing phase, the takeoff stage, the taxi stage, and the approach stage account for the largest proportion of accidents. Source: Statistical Summary of Commercial Jet Airplane Accidents, 1959 - 2008, Boeing

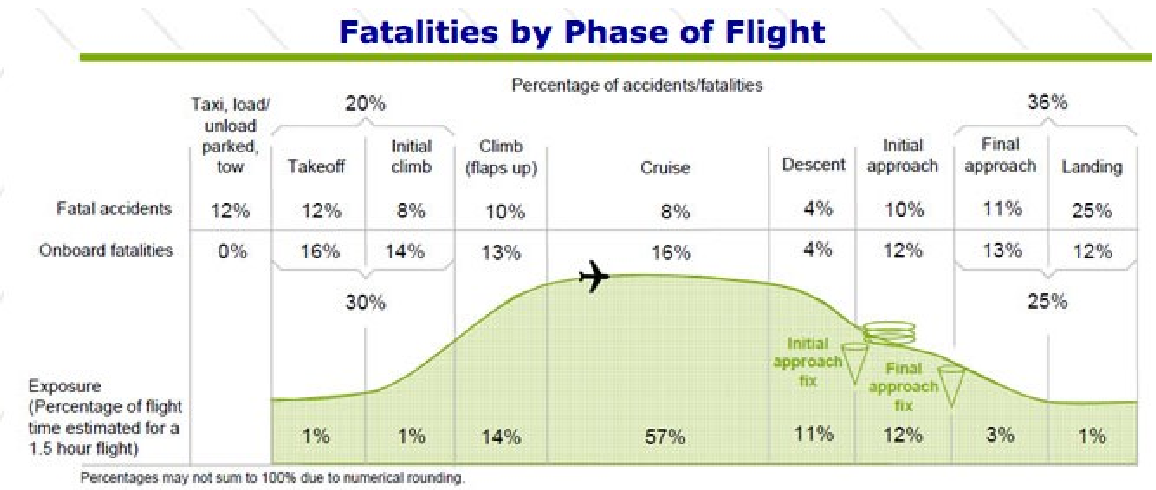

Table 1: Causes of fatal accidents per decade (percentage)

This table provides information on the causes of fatal accidents that occurred worldwide from 1950 to 2010 based on information provided by PlaneCrashInfo.com. Aircraft with 18 or less passengers aboard, military aircraft, private aircraft, and helicopters are excluded.

"Pilot error (in connection with bad weather)" represents accidents in which pilots made errors during flights in bad weather conditions. "Pilot error (mishandling of equipment)" represents accidents in which pilot errors occurred in connection with some type of mechanical failure. "Other human error" relates to accidents caused by several types of human factors, consisting of errors made by air traffic controllers, incorrect loading of aircraft, fuel contamination, and inappropriate performance of maintenance. “Weather related” refers to accidents that occurred due to severe weather conditions such as thunderstorms, lighting, fog, icing, and turbulence. “Mechanical failure” refers to accidents that occurred due to mechanical system failure or flaws in the plane’s design. “Criminal activities” includes crashes caused by explosive devices, shoot downs, and hijackings. “Wildlife strike” relates to accidents caused by wild animals such as birds, bats, and ground animals. For accidents with multiple causes, the most prominent cause is used.

Cause	*1950s*	*1960s*	*1970s*	*1980s*	*1990s*	*2000s*	*Average*
Pilot Error	42	34	25	29	29	34	32
Pilot Error (In Connection with Bad Weather)	10	17	14	16	21	18	16
Pilot Error (Mishandling of Equipment)	6	8	5	2	5	5	5
Total Pilot Error	58	59	44	47	55	57	53
Other Human Error	3	8	9	5	8	6	6
Weather-Related	16	8	14	14	8	6	12
Mechanical Failure	21	18	20	21	18	22	20
Criminal Activities	3	5	11	12	10	9	8
Wildlife Strike	0	2	2	1	1	0	1

Figure 2: A map of the 26 countries studied in this paper

This figure shows the geographical regions represented in our sample. While our sample selection is driven by the usual data availability limitations, it covers airlines from a variety of geographic locations, with distinct variations in economic strength and population. As such, it should provide a good reflection of the global aviation industry. Source: Google Maps

Table 2: Distribution of aviation accidents among our sample countries

This table shows the distribution of aviation accidents among our sample countries and also provides information on country statistics for each country (population, GDP, and the number of air passengers carried). Our data is retrieved from the World Bank database which defines a country's population as all residents of that country, regardless of legal status or citizenship (based on midyear estimates). GDP is measured as the total gross value added by all resident producers plus taxes and minus subsidies not included in the product's value. All GDP data are measured in current U.S. dollars. Finally, air passengers carried are calculated as the sum of all domestic and international aircraft passengers of airlines registered in the country. We report data for the first year of our sample (1990), the last year of our sample (2009), and the annual average for the full 1990-2009 sample period. Source: World Bank Database

Country	Number of Accidents	Average (1990-2009)				1990			2009		
		Number of passengers carried (million)	*GDP ($ billion)*	*GDP growth (%)*	*Population (million)*	*Number of passengers carried (million)*	*GDP ($ billion)*	*Population (million)*	*Number of passengers carried (million)*	*GDP ($ billion)*	*Population (million)*
Argentina	1	6.6	234.4	3.8	36.5	5.4	141.4	32.6	5.7	307.2	40.0
Austria	2	6.0	248.3	2.2	8.0	2.5	164.8	7.7	8.5	383.7	8.4
Brazil	16	31.6	784.3	2.5	172.7	19.1	462.0	149.6	67.9	1620.2	193.5
Canada	4	31.9	835.9	2.3	30.7	20.6	582.7	27.8	52.6	1337.6	33.7
Chile	1	4.7	90.1	5.1	15.3	1.4	31.6	13.2	8.1	172.0	17.0
Colombia	7	8.9	112.6	3.5	39.6	5.3	40.3	33.3	12.1	234.4	45.8
Ecuador	7	1.8	30.7	3.1	12.4	0.8	15.2	10.1	2.9	62.5	14.8
France	11	46.5	1720.5	1.6	61.2	36.0	1244.2	58.4	58.3	2619.7	64.7
Germany	2	60.0	2400.4	1.5	81.8	22.1	1714.5	79.4	103.4	3298.2	81.9
India	16	22.5	602.2	6.3	1032.4	10.9	326.6	868.9	54.4	1365.4	1190.1
Italy	10	28.8	1431.7	1.0	57.6	19.8	1138.1	56.7	33.2	2111.1	60.2
Japan	5	95.6	4373.5	1.0	126.4	76.2	3103.7	123.5	86.9	5035.1	127.6
Kenya	2	1.5	14.9	2.9	31.2	0.8	8.6	23.4	2.9	30.6	39.8
Malaysia	5	16.4	109.5	6.0	23.1	10.2	44.0	18.2	23.8	202.3	27.8
Mexico	6	18.3	643.1	2.7	102.2	14.3	262.7	86.1	15.7	895.4	116.4
Netherlands	2	19.8	489.4	2.4	15.8	8.6	294.9	15.0	29.1	796.3	16.5
Pakistan	7	5.4	84.3	4.2	141.1	5.2	40.0	111.1	5.3	168.2	170.1
Portugal	1	6.9	144.8	1.9	10.3	3.5	77.7	10.0	9.9	234.1	10.6
Singapore	2	14.3	100.2	6.2	3.9	7.0	36.1	3.0	18.4	194.1	5.0
South Korea	6	30.0	583.0	5.3	46.4	15.7	263.8	42.9	34.2	834.1	49.2
Spain	13	36.9	819.5	2.6	41.2	21.7	521.0	38.9	49.3	1454.3	45.9
Switzerland	3	11.8	326.2	1.5	7.2	8.6	244.0	6.7	14.7	509.5	7.7
Thailand	2	15.4	156.8	4.7	61.9	8.2	85.3	56.6	19.6	263.7	66.3
Turkey	6	12.3	311.4	3.9	62.7	4.3	150.7	54.0	31.3	614.6	71.2
UK	8	71.7	1666.2	2.3	59.1	47.1	1019.3	57.2	102.5	2208.0	61.8
US	70	600.5	10113.2	2.5	279.5	464.6	5979.6	249.6	679.4	14417.9	306.8

Table 3: Overview of explanatory variables

This table provides an overview of the explanatory variables used in our subsequent analysis. Panel A provides definitions for our firm-level explanatory variables. Panel B provides sources and descriptions for our country-level explanatory variables.

Variable	*Source*	*Description*
Panel A: Firm-level Explanatory Variables		
Current Ratio	ICAO database	We calculate the current ratio as follows: Current Ratio = Current Assets/Current Liabilities
Total Asset Turnover	ICAO database	We calculate the total asset turnover as follows: Total Asset Turnover = Sales/Total Assets
Debt Ratio	ICAO database	We calculate the debt ratio as follows: Debt Ratio = Total Liabilities/Total Assets
Net Profit Margin	ICAO database	We calculate the net profit margin as follows: Net Profit Margin = Net Income/Sales
ROA	ICAO database	We calculate the return on assets as follows: ROA = Net Income/Total Assets
ROE	ICAO database	We calculate the return on equity as follows: ROE = Net Income/Stockholders' Equity
Panel B: Country-level Explanatory Variables		
Ln(GDP per capita)	World Bank database	Natural log of GDP per capita
Ln(Departures)	World Bank database	Natural log of the number of domestic and international takeoffs of air carriers registered in the country
Unemployment	World Bank database	Unemployment rate (in %)
Efficiency of the Judicial System	La Porta et al. (1998)	Assessment of the efficiency and integrity of the legal environment as it affects business. Scale from zero to ten, with lower scores representing lower efficiency levels. (La Porta et al., 1998)
Rule of Law	La Porta et al. (1998)	Assessment of the law and order tradition in the country. Scale from zero to ten, with lower scores for less tradition for law and order. (La Porta et al., 1998)
Corruption	La Porta et al. (1998)	Assessment of the corruption in government. Lower scores indicate that high government officials are likely to demand special payments and illegal payments are generally expected throughout lower levels of government. Scale from zero to ten, with lower scores for higher levels of corruption. (La Porta et al., 1998)
Common Law Dummy	Reynolds and Flores (1989)	Identifies whether the legal system of a given country originates from English common law (dummy variable: 1=yes, 0=no)

Table 4: Descriptive statistics

Our sample for this study consists of 110 airlines from 26 countries during the period 1990 to 2009. Due to the entry and exit of several air carriers during that timeframe and due to missing data, the data set is unbalanced. We consider a four year time span as the observation window, i.e. we merge each airline's data every four years. Thus, we end up with 252 country four-year observations in our data set. We proxy for an airline's safety performance using the number of accidents of an airline during a four year period divided by the operating revenues of the airline over that four year period. Panel A provides sample summary statistics for our measures of safety performance and financial performance. We distinguish between airlines with and without accidents during a four year period. For each subsample, we report the number of observations, as well as the mean and median for each firm-level financial variable. We employ t-tests and Mann–Whitney tests to test for the equality of means and medians between each subsample. The last column reports p-values for both tests. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Descriptive statistics

Panel A. All airlines

Variable	*Obs.*	*Mean*	*Median*	*Std.dev.*	*Min.*	*Max.*
Accidents (Per 4 years)	252	0.5198	0	0.8947	0	5
Accident Frequency (Per 4 years)	252	0.3641	0	0.9644	0	8.7648
Current Ratio	252	0.9512	0.8517	0.4706	0.2059	3.7177
Total Asset Turnover	252	1.2850	1.0846	0.7371	0.3038	4.1774
Debt Ratio	252	0.8823	0.8312	0.3113	0.3796	3.6260
Net Profit Margin	252	-0.0166	-0.0003	0.0847	-0.4531	0.2405
ROA	252	-0.0229	0.0012	0.1091	-0.6316	0.2382
ROE	252	0.0841	0.0855	1.0977	-8.3094	6.1399

Panel B. Subsample Equality Tests

	Subsample 1 ***Airlines with accidents*** ***(N=87)***	***Subsample 2*** ***Airlines without accidents*** ***(N=165)***	
Variable	***Mean, Median***	***Mean, Median***	***Tests of differences*** ***Means (p-value)*** ***Medians (p-value)***
	0.8604	0.9991	0.0258**
Current Ratio	0.7830	0.8905	0.0354**
	1.0808	1.3927	0.0013***
Total Asset Turnover	0.9564	1.2065	0.0073***
	0.8796	0.8837	0.9204
Debt Ratio	0.8473	0.8294	0.5480
	-0.0221	-0.0137	0.4533
Net Profit Margin	-0.0056	0.0042	0.2782
	-0.0297	-0.0192	0.4685
ROA	-0.0034	0.0052	0.2181
	-0.0807	0.1710	0.0836*
ROE	0.0543	0.0920	0.2195

Table 5: Country characteristics

This table lists all countries in our sample by GDP rank based on 2012 data and shows the country-level variables for each country. Following La Porta et al. (1998), we consider the efficiency of the judicial system, the rule of law, and corruption to characterize the different institutional environments across countries. These measures are scored from zero to ten, with lower scores representing a lower quality institutional environment of a country. In addition, we employ a common law dummy to identify whether the legal system of a given country originates from English common law. The variable equals one if the origin is English common law and zero otherwise.

Country characteristics					
GDP Rank (based on 2012 rankings by the United Nations)	***Country***	***Efficiency of the Judicial System***	***Rule of Law***	***Corruption***	***Common Law Origin***
1	USA	10	10	8.63	1
3	Japan	10	8.98	8.52	0
4	Germany	9	9.23	8.93	0
5	France	8	8.98	9.05	0
6	UK	10	8.57	9.1	1
7	Brazil	5.75	6.32	6.32	0
9	Italy	6.75	8.33	6.13	0
10	India	8	4.17	4.58	1
11	Canada	9.25	10	10	1
13	Spain	6.25	7.8	7.38	0
14	Mexico	6	5.35	4.77	0
15	South Korea	6	5.35	5.3	0
17	Turkey	4	5.18	5.18	0
18	Netherlands	10	10	10	0
20	Switzerland	10	10	10	0
26	Argentina	6	5.35	6.02	0
27	Austria	9.5	10	8.57	0
28	Thailand	3.25	6.25	5.18	1
32	Colombia	7.25	2.08	5	0
34	Malaysia	9	6.78	7.38	1
35	Singapore	10	8.57	8.22	1
36	Chile	7.25	7.02	5.3	0
43	Pakistan	5	3.03	2.98	1
44	Portugal	5.5	8.68	7.38	0
63	Ecuador	6.25	6.67	5.18	0
88	Kenya	5.75	5.42	4.82	1

Table 6: Correlation Coefficients

This table reports Pearson correlation coefficients between each pair of variables. We observe a high correlation between a country's GDP, the corruption index, and the rule of law (with correlation coefficients >0.8). To avoid any multicollinearity problems in our subsequent regression models, we include those three variables separately.

	Current ratio	Total asset turnover	Debt ratio	Net profit margin	ROA	ROE	Ln(GDP)	Ln(Depa-tures)	Unemploy-ment	Efficiency of the judicial system	Corruption	Rule of law	Common law dummy
Current ratio	1												
Total asset turnover	-0.0725	1											
Debt ratio	-0.2773	0.3600	1										
Net profit margin	0.2592	-0.0548	-0.4004	1									
ROA	0.3046	-0.2499	-0.6420	0.7908	1								
ROE	-0.0339	0.0601	0.1230	0.1262	0.0327	1							
Ln(GDP)	-0.0840	0.1083	-0.0753	0.1287	0.0665	0.1525	1						
Ln(Departures)	-0.0702	0.1133	0.0456	0.0377	0.0053	0.1288	0.6386	1					
Unemployment	-0.0713	0.1752	0.0663	-0.2021	-0.1164	-0.1055	-0.0560	-0.1807	1				
Efficiency of judicial system	0.0766	0.0295	-0.1013	0.2042	0.1362	0.1109	0.6399	0.6617	-0.3229	1			
Corruption	-0.0017	0.0850	-0.0434	0.1512	0.0836	0.1408	0.8681	0.5593	-0.0563	0.7836	1		
Rule of law	-0.0293	0.0360	-0.0365	0.1521	0.0830	0.1822	0.8852	0.6765	-0.1664	0.6970	0.8920	1	
Common law dummy	0.0556	-0.0288	-0.0446	0.1969	0.1566	0.0562	0.1598	0.5527	-0.4262	0.6088	0.3361	0.3506	1

Table 7: OLS regression results

This table provides regression results for models in which we regress an airline's accident frequency on six firm-level financial variables and seven country-level variables during our sample period from 1990 to 2009. Specifically, we estimate the basic model as follows:

$$\frac{N(Accidents)}{OperatingRevenue} = \beta_0 + \beta_1 Liquidity + \beta_2 Leverage + \beta_3 Activity + \beta_4 Profitablity$$

$$+\beta_5 ln(GDPperCapita) + \beta_6 ln(Departures) + \beta_7 Unemployment + \beta_8 LegalVariables + \varepsilon$$

As noted in Table 6, there is a high correlation between the GDP per capita, the corruption index, and the rule of law for our sample countries. Thus we only include Ln(GDP) in our base model. Panel A reports our regression results for a series of models that consider an airline's financial condition. Model 1 is our base model. Models 2 and 3 vary from our base model by using different profitability measures. Models 4 to 9 estimate each financial variable's impact on accident frequency while controlling for other relevant factors. Panel B reports our regression results related to the macroeconomic environment of a given country. We include each country variable separately to observe its individual effect. The results are reported in Model 10 to 15. For each variable, we report the coefficient and the corresponding p-value in parentheses. In the last three rows, we report the adjusted R^2, the p-value for an F-test, and the number of observations for each regression. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Summary of Firm-level Results (DV=Accident Frequency)									
Variable	***Base Model***	***Variations on base model***							
	Model 1	***Model 2***	***Model 3***	***Model 4***	***Model 5***	***Model 6***	***Model 7***	***Model 8***	***Model 9***
Constant	2.6373*** (0.0000)	2.7726*** (0.0000)	2.4505*** (0.0001)	2.4675*** (0.0000)	2.2432*** (0.0000)	2.2809*** (0.0001)	2.2461*** (0.0000)	2.2589*** (0.0000)	2.1564*** (0.0001)
Current ratio	-0.1169 (0.3747)	-0.1175 (0.3738)	-0.1662 (0.2054)	-0.1503 (0.2330)					
Total asset turnover	-0.0074 (0.9321)	-0.0384 (0.6560)	-0.0317 (0.7145)		-0.0420 (0.6038)				
Debt ratio	-0.2785 (0.2133)	-0.4199 (0.1008)	-0.0541 (0.7997)			-0.0505 (0.7908)			
Net profit margin	-1.9262** (0.0151)						-1.7002** (0.0182)		
ROA		-1.6153** (0.0236)						-0.9427* (0.0841)	
ROE			-0.0745 (0.1703)						-0.0762 (0.1553)
Ln(GDP)	-0.3055*** (0.0001)	-0.3181*** (0.0000)	-0.3205*** (0.0000)	-0.3268*** (0.0000)	-0.3157*** (0.0000)	-0.3187*** (0.0000)	-0.2901*** (0.0002)	-0.3035*** (0.0001)	-0.3077*** (0.0001)
Ln(Departures)	0.0715 (0.1921)	0.0828 (0.1281)	0.0921* (0.0924)	0.0852 (0.1139)	0.0934* (0.0842)	0.0933* (0.0881)	0.0647 (0.2335)	0.0749 (0.1677)	0.0936* (0.0814)
Efficiency of the judicial system	0.0082 (0.8833)	0.0035 (0.9504)	0.0072 (0.8994)	0.0089 (0.8745)	-0.0026 (0.9628)	-0.0034 (0.9522)	0.0043 (0.9374)	0.0011 (0.9842)	-0.0040 (0.9427)
Unemployment	0.0012 (0.9472)	0.0061 (0.7308)	0.0043 (0.8131)	0.0054 (0.7601)	0.0074 (0.6792)	0.0060 (0.7355)	0.0011 (0.9484)	0.0047 (0.7886)	0.0034 (0.8489)
Common law dummy	-0.0763 (0.6905)	-0.0816 (0.6706)	-0.1479 (0.4387)	-0.1394 (0.4641)	-0.1371 (0.4724)	-0.1383 (0.4695)	-0.0661 (0.7292)	-0.0872 (0.6493)	-0.1392 (0.4642)
Adjusted R^2	0.1122	0.1094	0.0973	0.0995	0.0953	0.0945	0.1147	0.1052	0.1017
F-test (p-value)	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	252	252	252	252	252	252	252	252	252

Panel B. Summary of Country-level Results (DV=Accident Frequency)								
Variable	***Base Model***	***Variations on base model***						
	Model 1	***Model 10***	***Model 11***	***Model 12***	***Model 13***	***Model 14***	***Model 15***	***Model 16***
Constant	2.6373*** (0.0000)	2.9648*** (0.0000)	1.5404*** (0.0042)	1.3435*** (0.0005)	1.5738*** (0.0000)	1.7790*** (0.0000)	0.5258* (0.0628)	0.5681** (0.0348)
Current ratio	-0.1169 (0.3747)	-0.1130 (0.3831)	-0.0455 (0.7342)	-0.0173 (0.8966)	-0.0639 (0.6239)	-0.0491 (0.7050)	-0.0241 (0.8583)	-0.0244 (0.8564)
Total asset turnover	-0.0074 (0.9321)	-0.0020 (0.9810)	-0.0435 (0.6199)	-0.0490 (0.5720)	-0.0475 (0.5751)	-0.0254 (0.7648)	-0.0653 (0.4658)	-0.0626 (0.4771)
Debt ratio	-0.2785 (0.2133)	-0.2518 (0.2546)	-0.1344 (0.5573)	-0.1624 (0.4758)	-0.1418 (0.5243)	-0.1648 (0.4581)	-0.1357 (0.5588)	-0.1371 (0.5534)
Net profit margin	-1.9262** (0.0151)	-2.0227*** (0.0079)	-2.3664*** (0.0028)	-2.1018*** (0.0082)	-1.9480** (0.0120)	-1.9788** (0.0104)	-2.4350*** (0.0028)	-2.4318*** (0.0028)
Ln(GDP)	-0.3055*** (0.0001)	-0.2381*** (0.0000)						
Ln(Departures)	0.0715 (0.1921)		-0.0725** (0.0357)					
Efficiency of the judicial system	0.0082 (0.8833)			-0.0917*** (0.0059)				
Rule of law					-0.1206*** (0.0000)			
Corruption						-0.1575*** (0.0000)		
Unemployment	0.0012 (0.9472)						0.0035 (0.8351)	
Common law dummy	-0.0763 (0.6905)							-0.0310 (0.8078)
Adjusted R^2	0.1122	0.1193	0.0430	0.0553	0.0958	0.1008	0.0258	0.0258
F-test (p-value)	0.0000	0.0000	0.0073	0.0019	0.0000	0.0000	0.0433	0.0430
N	252	252	252	252	252	252	252	252

Table 8: OLS regression results after winsorizing

In order to avoid any effects that extreme values may have on our results, we reestimate our models using winsorized data, i.e. data in which we remove the bottom and top 5% of all observations in terms of our six firm-level financial variables: the current ratio, total asset turnover, the debt ratio, net profit margin, ROA, and ROE. Specifically, we estimate the base model as follows: $\frac{N(Accidents)}{OperatingRevenue} = \beta_0 + \beta_1 Liquidity + \beta_2 Leverage + \beta_3 Activity + \beta_4 Profitablity$

$+\beta_5 ln(GDPperCapita) + \beta_6 ln(Departures) + \beta_7 Unemployment + \beta_8 LegalVariables + \varepsilon$

Panel A reports our regression results for a series of models that consider an airline's financial condition and Panel B reports our regression results related to the macroeconomic environment of a given country. For each variable, we report the coefficient and the corresponding p-value in parentheses. In the last three rows, we report the adjusted R^2, the p-value for an F-test, and the number of observations for each regression. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Variable	Base Model	Variations on base model							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Panel A. Summary of Firm-level Results (DV=Accident Frequency)									
Constant	2.4636*** (0.0004)	2.5427*** (0.0003)	2.0408*** (0.0036)	2.4308*** (0.0000)	2.2441*** (0.0000)	2.0317*** (0.0009)	2.2459*** (0.0000)	2.2854*** (0.0000)	2.2218*** (0.0000)
Current ratio	-0.0114 (0.9458)	-0.0220 (0.8964)	-0.1070 (0.5190)	-0.1428 (0.3603)					
Total asset turnover	-0.0287 (0.7487)	-0.0601 (0.5045)	-0.0327 (0.7177)		-0.0316 (0.7198)				
Debt ratio	-0.2476 (0.5406)	-0.2669 (0.5252)	0.3967 (0.3051)			0.2601 (0.4487)			
Net profit margin	-3.0842 (0.0044)						-2.7790*** (0.0029)		
ROA		-2.2112** (0.0133)						-1.8531** (0.0110)	
ROE			-0.2021* (0.0657)						-0.1671 (0.1109)
Ln(GDP)	-0.2797*** (0.0003)	-0.2950*** (0.0001)	-0.3029*** (0.0001)	-0.3232*** (0.0000)	-0.3161*** (0.0000)	-0.3144*** (0.0000)	-0.2815*** (0.0002)	-0.2967*** (0.0001)	-0.3046*** (0.0000)
Ln(Departures)	0.0578 (0.2893)	0.0672 (0.2172)	0.0820 (0.1310)	0.0862 (0.1106)	0.0927* (0.0868)	0.0866 (0.1095)	0.0562 (0.2982)	0.0649 (0.2298)	0.0901* (0.0929)
Efficiency of the judicial system	0.0041 (0.9419)	0.0033 (0.9533)	0.0007 (0.9905)	0.0063 (0.9108)	-0.0025 (0.9643)	0.0013 (0.9821)	0.0060 (0.9125)	0.0046 (0.9331)	-0.0096 (0.8639)
Unemployment	0.0008 (0.9656)	0.0054 (0.7625)	0.0033 (0.8543)	0.0058 (0.7439)	0.0069 (0.6984)	0.0051 (0.7721)	-0.0003 (0.9885)	0.0031 (0.8607)	0.0037 (0.8323)
Common law dummy	-0.0263 (0.8917)	-0.0538 (0.7799)	-0.1264 (0.5071)	-0.1412 (0.4588)	-0.1365 (0.4746)	-0.1386 (0.4674)	-0.0385 (0.8395)	-0.0673 (0.7233)	-0.1194 (0.5301)
Adjusted R^2	0.1180	0.1108	0.1006	0.0974	0.0947	0.0964	0.1266	0.1179	0.1036
F-test (p-value)	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	252	252	252	252	252	252	252	252	252

Panel B. Summary of Country-level Results (DV=Accident Frequency)								
Variable	***Base Model***	***Variations on base model***						
	Model 1	***Model 10***	***Model 11***	***Model 12***	***Model 13***	***Model 14***	***Model 15***	***Model 16***
Constant	2.4636*** (0.0004)	2.7418*** (0.0000)	1.3962** (0.0260)	1.4303*** (0.0021)	1.3951*** (0.0027)	1.5829*** (0.0010)	0.4445 (0.3040)	0.4502 (0.2831)
Current ratio	-0.0114 (0.9458)	-0.0136 (0.9345)	0.0553 (0.7461)	0.0413 (0.8032)	0.0404 (0.8079)	0.0591 (0.7209)	0.0877 (0.6093)	0.0878 (0.6090)
Total asset turnover	-0.0287 (0.7487)	-0.0218 (0.8031)	-0.0557 (0.5388)	-0.0559 (0.5231)	-0.0622 (0.4778)	-0.0438 (0.6175)	-0.0782 (0.3962)	-0.0775 (0.3934)
Debt ratio	-0.2476 (0.5406)	-0.2283 (0.5673)	-0.1329 (0.7483)	-0.1575 (0.6976)	-0.0929 (0.8179)	-0.1041 (0.7960)	-0.1435 (0.7318)	-0.1447 (0.7306)
Net profit margin	-3.0842*** (0.0044)	-3.1477*** (0.0021)	-3.6874*** (0.0005)	-3.3794*** (0.0015)	-3.0801*** (0.0031)	-3.0740*** (0.0031)	-3.8492*** (0.0004)	-3.8586*** (0.0004)
Ln(GDP)	-0.2797*** (0.0003)	-0.2262*** (0.0000)						
Ln(Departures)	0.0578 (0.2893)		-0.0691** (0.0443)					
Efficiency of the judicial system	0.0041 (0.9419)			-0.0854** (0.0100)				
Rule of law					-0.1156*** (0.0000)			
Corruption						-0.1510*** (0.0000)		
Unemployment	0.0008 (0.9656)						0.0008 (0.9630)	
Common law dummy	-0.0263 (0.8917)							-0.0006 (0.9960)
Adjusted R^2	0.1180	0.1266	0.0573	0.1096	0.1058	0.1103	0.0417	0.0417
F-test (p-value)	0.0000	0.0000	0.0015	0.0000	0.0000	0.0000	0.0084	0.0084
N	252	252	252	252	252	252	252	252

Table 9: Alternative regression results, using Altman's Z-Score to measure financial health

We conduct an alternative test to investigate whether there is a relationship between a firm's financial performance and its safety performance by using Altman's Z-score (Z score), which was originally proposed by Altman (1968) to determine a firm's financial health. Altman (2001) devised the calculation for firms that are not engaged in manufacturing as follows: $Z=6.56*X1+3.26*X2+6.72*X3+1.05*X4$, where X1 is working capital/total assets, X2 is retained earnings/total assets, X3 is earnings before interest and taxes/total assets, and X4 denotes the book value of equity/total liabilities. For each variable, we report the coefficient and the corresponding p-value in parentheses. In the last three rows, we report the adjusted R^2, the p-value for an F-test, and the number of observations for each regression. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Summary of Altman's Z Score Results (DV=Accident Frequency)								
Variable	***Base model***	***Variations on base model***						
	Model 1	***Model 2***	***Model 3***	***Model 4***	***Model 5***	***Model 6***	***Model 7***	***Model 8***
Constant	1.6061**	2.2537***	0.6178	0.8861**	1.3103***	1.5062***	0.4785***	0.2949*
	(0.0393)	(0.0008)	(0.3757)	(0.0345)	(0.0009)	(0.0004)	(0.0095)	(0.0717)
Altman's Z Score	-0.0427	-0.0483	-0.0497	-0.0459	-0.0501	-0.0479	-0.0504	-0.0510
	(0.1702)	(0.1138)	(0.1099)	(0.1398)	(0.1025)	(0.1172)	(0.1053)	(0.1029)
Ln(GDP)	-0.3125***	-0.1937***						
	(0.0079)	(0.0043)						
Ln(Departures)	0.1360*		-0.0181					
	(0.0790)		(0.7155)					
Efficiency of the judicial system	0.0047			-0.0592**				
	(0.9560)			(0.0469)				
Rule of law					-0.1115**			
					(0.0131)			
Corruption						-0.1439***		
						(0.0056)		
Unemployment	-0.0082						-0.0175	
	(0.7579)						(0.4837)	
Common law dummy	-0.1102							0.0981
	(0.7090)							(0.6071)
Adjusted R^2	0.0377	0.0383	0.0029	0.0167	0.0295	0.0362	0.0045	0.0035
F-Test (p-value)	0.0248	0.0048	0.2663	0.0808	0.0131	0.0061	0.2226	0.2493
N	226	226	226	226	226	226	226	226

Appendix 1: Airlines included in the data set

Carrier	*Country*	*Basic data availability*
ACES	Colombia	1991-1994, 1996-1999
Aerolineas Argentinas	Argentina	1992-1995, 2001-2004
Aerolineas Galapagos	Ecuador	2004-2007
Aeromexico	Mexico	1990-2001, 2005-2008
Air Canada	Canada	1990-2009
Air Deccan	India	2003-2006
Air Europa	Spain	1996-2007
Air France	France	1994-2009
Air France Europe	France	1990-1993
Air India	India	1990-2005
Air Nippon	Japan	1998-2001
Air Nostrum	Spain	1996-2007
Air Wisconsin	USA	2002-2009
Airtran Airways	USA	2001-2008
Alaska	USA	1990-2009
Alitalia	Italy	1990-1997
Alitalia Team	Italy	1992-1995
All Nippon Airways	Japan	1995-2002
Aloha	USA	2000-2007
America West	USA	1990-2005
American	USA	1990-2009
American Eagle	USA	1998-2001, 2003-2006
Aom French Airlines	France	1992-1995
Asiana	Korea	1993-1996, 2003-2006
ATA Airlines	USA	1992-1999
Atlantic Southeast	USA	2001-2008
AUA	Austria	1990-2001
Austral	Argentina	2001-2004
Aviacsa	Mexico	2001-2004
Avianca	Colombia	1990-2001
BA Connect	UK	1998-2005
Berjaya Air	Malaysia	2002-2009
Binter Canarias	Spain	1990-2001
British Airways	UK	1990-2009
British Med. Airways	UK	2001-2004
British Midland	UK	1990-2009
Canadian	Canada	1990-1997
Cathay Pacific	UK	1990-1993
Cityflyer Express	UK	1997-2000
Comair	USA	2005-2008
Continental	USA	1990-2009
Continental Micronesia	USA	1996-2007
Copa Airlines Colombia	Colombia	1996-1999
Delta	USA	1990-2009
Duo Airways	UK	1995-1998
Easyjet Airline	UK	2004-2007
Endeavor Air	USA	2004-2007
Expressjet Airline	USA	1997-2000, 2004-2007
First Choice Airways	UK	1994-1997

Flybe British European	UK	1998-2005
Frontier Airlines	USA	2002-2009
GB airways	UK	1992-2003
GOL	Brazil	2005-2008
Hawaiian Airlines	USA	1990-2009
Helvetic Airways	Switzerland	2003-2006
Horizon Air	USA	1990-2009
Iberia	Spain	1990-2009
Indian Airlines	India	1990-1993, 1997-2000
JAL	Japan	1995-1998
JAL International	Japan	2004-2007
Japan Asia Airways	Japan	1995-1998
Jet Airways	India	1997-2008
Jet Lite	India	1998-2005
Jet2	UK	2002-2009
Jetblue Airways	USA	2002-2009
Kenya Airways	Kenya	2001-2004
KLM	Netherlands	1994-2001
KLM UK	UK	1994-2001
Korean Air	Korea	1992-1999, 2006-2009
Lan Cargo	Chile	1990-1993
Lan Chile	Chile	1990-1993, 2000-2003
LAPA	Argentina	1997-2000
Lufthansa	Germany	1990-2009
Malaysian Airlines	Malaysia	1990-1993, 2006-2009
Meridiana Fly	Italy	1990-1997
Mesaba Aviation	USA	2003-2006
Mexicana	Mexico	1990-2005
Midwest Express	USA	1995-1998, 2001-2008
Monarch Airlines	UK	1990-1993, 1996-1999, 2003-2006
Nordeste	Brazil	2001-2004
Northwest	USA	1990-2005
Pantanal	Brazil	2001-2004
PIA	Pakistan	1990-2005
Portugalia	Portugal	2001-2004
Reno Air	USA	1995-1998
Rio Sul	Brazil	2001-2004
SAM	Colombia	2000-2003
Sata International	Portugal	2004-2007
SIA	Singapore	1990-2007
Silkair	Singapore	1998-2001
Skywest Airlines	USA	2004-2007
Southwest	USA	2002-2009
Spanair	Spain	1995-2002, 2005-2008
Spirit Airlines	USA	2002-2009
Sun Country	USA	2005-2008
Swiss	Switzerland	1994-1997, 2002-2009
Swissair	Switzerland	1995-1998
TAME	Ecuador	2005-2008
Tap Air Portugal	Portugal	1990-1997, 2006-2009
TAT European Airline	France	1990-1993
Thai Airways	Thailand	1990-2005
Thomsonfly	UK	1990-1993
THY	Turkey	1991-1994
Tower Air	USA	1990-1997
Trans States Airlines	USA	2002-2005

TWA	USA	1994-2001
United	USA	1990-2009
US Airways	USA	1990-2009
Varig	Brazil	1990-1993, 2001-2004
Virgin Atlantic	UK	1990-2009

Appendix 2: Brief details about accidents involving our sample airlines

This appendix provides details on some of the accidents involving our sample airlines from 1990 to 2009. We only consider accidents that resulted in a total loss of the plane while accidents resulting in a repairable damage are not included. The details below are based on initial news releases and subsequent accident reports provided by the National Transportation Safety Board (NTSB).

January 05, 1990, Villa Gesell, Argentina, Aerolineas Argentinas. The aircraft was substantially damaged by fire after a hard landing. Ninety people on board were safely evacuated.
January 25, 1990, Cove Neck, New York, Avianca. 73 of the 158 people on board were killed in the accident. The National Transportation Safety Board determined that the accident was primarily due to the flight crew's failure to report a fuel emergency, leading to the air traffic controller underestimate the volatile situation of bad weather.
February 14, 1990, Near Bangalore, India, Indian Airlines. The aircraft carrying 146 people crashed on its final approach to Bangalore airport, causing 92 fatalities. The pilots' lack of familiarity with the behavior of the aircraft under different modes of operation was reported as the primary cause of the accident.
May 07, 1990, Delhi, India, Air India. All 215 passengers and crew on board survived but the aircraft was damaged beyond repair. Improper landing that led to engine failure and separation probably caused the accident.
May 10, 1990, Tuxtla Gutiérrez, Mexico, Aviacsa. The aircraft crashed after striking trees on its approach to the runway. A lack of coordination amongst the flight crew during the approach, and their lack of experience with the aircraft contributed to the accident. 21 persons on board died, 17 survived.
July 22, 1990, Kinston, North Carolina, US Airways. All 27 passengers and crew survived, however, the aircraft was damaged beyond repair and was written-off. The crash may have been related to the fuel pump control shaft's failure caused by improper procedures during maintenance modification of the pump and incorrect procedures during the overall inspection of the nose landing gear.
November 14, 1990, Stadelberg, Switzerland, Alitalia. The aircraft crashed into the mountain Stadlerberg when approaching Zurich airport, killing all 46 person on board. Pilot misreading of the altimeter and non-compliance between the pilot and co-pilot were initially reported as the probable cause.
December 03, 1990, Romulus, Michigan, Northwest Airlines. A runway collision happened between two Northwest Airlines planes (a Douglas DC-9 and Boeing 727) at Detroit Metropolitan Airport on December 3, 1990. One crew and seven passengers on board of the DC-9 were killed. The other Northwest aircraft was safely evacuated. As reported by The National Transportation Safety Board, contributing to this accident was the lack of proper crew coordination aboard the DC-9, which led to their failure to stop the DC-9 taxiing onto the active runway and promptly notifying the ground controller of their positional uncertainty.
February 01, 1991, Los Angeles, California, US Airways. 34 persons on board died, 67 survived. The USAir plane collided with a commuter plane upon landing. Both planes overshot the runway, slammed into an unoccupied fire station and burst into flames.
February 20, 1991, Puerto Williams, Chile, LAN. The aircraft failed to stop upon landing at Puerto Williams Airport after a flight from Punta Arenas. The plane slid off the runway into the water of the Beagle Channel. 20 persons on board died, 50 survived.
March 03, 1991, Near Colorado Springs, Colorado, United Airlines. 25 persons on board died, none survived. The aircraft crashed into a dry lake while attempting to land.
April 05, 1991, Brunswick, Georgia, Atlantic Southeast. The aircraft crashed into the ground during its landing approach. 23 persons on board were killed. The investigation conducted by The National Transportation Safety Board found that Atlantic Southeast was overworking its pilots, which had a direct

effect on pilots' fitness and performance and was responsible for the pilots not perceiving a problem with the aircraft until it lost directional control.

June 13, 1991, Taegu, South Korea, Korean Air. The aircraft performed a hard landing at Daegu. The crew misread the landing procedure checklist and did not lower the gear. There were no fatalities but the aircraft was damaged beyond repair.

August 16, 1991, Imphal, India, Indian Airlines. The aircraft hit the ground during its landing approach to Imphal. The failure of the crew to follow the correct approach procedure is a likely cause of the accident. 69 persons on board died, none survived.

December 17, 1991, Warszawa, Poland, Alitalia. The nose gear of the aircraft collapsed after an unstabilized approach. All 96 passengers and crew survived, however the aircraft was damaged beyond repair and written-off.

January 18, 1992, Elmira, New York, US Airways. The aircraft suffered substantial damage and was written-off after its hard touchdown at Elmira Regional Airport. There were no fatalities.

March 22, 1992, New York, New York, US Airways. 27 persons on board died, 24 survived. The aircraft crashed while trying to take off from La Guardia airport in a snowstorm. The plane skidded off the runway and fell into Flushing Bay.

July 30, 1992, New York, New York, Trans World Airlines. The aircraft crashed after an aborted takeoff from JFK International Airport to San Francisco International Airport. In the final investigation report of The National Transportation Safety Board, the accident was attributed to pilot error and Trans World Airlines training and maintenance issues. All 292 people on board survived, though the aircraft was destroyed by the fire.

July 31, 1992, Near Kathmandu, Nepal, Thai Airways. The airplane with 113 persons on board crashed on its approach to Tribhuvan International Airport. All people on board were killed.

September 28, 1992, Near Kathmandu, Nepal, Pakistan International Airlines. The plane crashed on its approach to Kathmandu's Tribhuvan International Airport. All 167 persons on board died.

November 20, 1992, San Luis, Argentina, Aerolineas Argentinas. The airplane with 113 persons on board overran the runway and caught fire after an aborted takeoff at the San Luis Airport. There were no fatalities but the aircraft was damaged beyond repair.

January 09, 1993, Delhi, India, Indian Airlines. The aircraft overshot the runway during landing and collided with some fixed installations on the ground. There were no fatalities but the aircraft caught fire and was destroyed.

April 14, 1993, Dallas, Texas, American Airlines. All 202 passengers and crew survived, however the aircraft was damaged beyond repair and was written-off. The crash may have been related to the pilot's error to conduct proper procedures to maintain directional control of the aircraft.

April 26, 1993, Aurangabad, India, Indian Airlines. The aircraft crashed after an aborted takeoff at Aurangabad Airport. The crash was attributed to the failure of the pilots to follow proper rotation techniques and initiate rotation timely. 56 persons on board died, 62 survived.

May 19, 1993, Medellín, Colombia, SAM Colombia. The plane hit Mountain Paramo Frontino on its approach to Maria Cordova Airport. All 132 persons on board died.

July 26, 1993, Mokpo, South Korea, Asiana Airlines. The plane crashed on its final approach to Mokpo Airport. 68 people on board died, 48 survived. The investigation found the pilot's action was the cause of the crash. The decision to descend was taken while the plane was still near the summit of a mountain.

September 14, 1993, Warsaw, Poland, Lufthansa. The aircraft skidded off the end of the runway while landing. 2 persons on board died, 68 survived. Incorrect decisions and improper actions of the flight crew were reported as the main cause of the accident.

November 15, 1993, Tirupati, India, Indian Airlines. The aircraft made a forced landing on account of a shortage of fuel. There were no fatalities but the aircraft was damaged beyond repair. Incorrect decisions and improper actions of the flight crew were reported as the main cause of the accident.

July 02, 1994, Charlotte, North Carolina, US Airways. The aircraft crashed upon landing outside the runway. All five crew survived, but 37 of the 52 passengers were killed. The National Transportation

Safety Board determined that incorrect decisions and actions of the flight crew were the main cause of the accident.

July 05, 1994, Dera Ismail Khan, Pakistan, Pakistan International Airlines. The plane crashed upon approach to Dera Ismail Khan Airport and collided with a tree after sliding for 300m. There were no fatalities but the aircraft was damaged beyond repair.

September 08, 1994, Near Aliquippa, Pennsylvania, US Airways. The flight crashed during its landing approach to Pittsburgh International Airport. All 132 persons on board died. The crash may be related to the lack of altitude training for the flight crew.

December 29, 1994, Near Van, Turkey, Turkish Airlines. The aircraft crashed into a hill during its landing attempt to Van Airport. 57 persons on board died, 19 survived. Incorrect decisions and improper actions of the flight crew were reported as the main cause of the accident.

February 02, 1995, Kuala Lumpur, Malaysia, Berjaya Air. The Berjaya Air plane collided with the parked Pelangi Air commuter aircraft. There were no fatalities but the aircraft was damaged beyond repair.

August 21, 1995, Atlanta, Georgia, Atlantic Southeast. The plane crashed near Atlanta, Georgia during the landing approach. Nine of the 29 passengers and crew on board were killed as a result of the accident. Inadequate overhaul and repair techniques of the plane's propellers appear to have been a contributing factor.

August 23, 1995, Los Angeles, California, Delta Airlines. The aircraft suffered substantial damage due to a rapid decompression over the Pacific Ocean. The flight returned to Los Angeles for an emergency landing. There were no fatalities but the aircraft was damaged beyond repair. The National Transportation Safety Board determined that the lack of a required inspection of the airframe appears to have been a contributing factor.

September 15, 1995, Tawau, Malaysia, Malaysia Airlines. While attempting to land, the aircraft overran the runway and burst into a shantytown. 34 persons on board died, 19 survived. Incorrect decisions and improper actions of the flight crew were reported as the main cause of the accident.

December 02, 1995, Delhi, India, Indian Airlines. The plane overran the end of the runway after an unstabilized approach. There were no fatalities but the aircraft was damaged beyond repair. Incorrect decisions and improper actions of the flight crew were reported as the main cause of the accident.

December 20, 1995, Near Buga, Colombia, American Airlines. The flight crashed into a hill in Buga, Colombia, killing 159 people on board with 4 survivors. Navigational error by the flight crew is a strong possibility.

December 20, 1995, New York, New York, Tower Air. The flight veered off the runway during takeoff at JFK Airport. There were no fatalities among all 468 people on board but the aircraft was damaged beyond repair. The National Transportation Safety Board determined that the accident was primarily due to the captain's incorrect decision of taking off, coupled with inadequate runway operations of Tower Air.

February 19, 1996, Houston, Texas, Continental Airlines. The aircraft overran the end of the runway after an unstabilized approach. No fatalities occurred but the aircraft was damaged beyond repair. The crew's failures to complete the landing procedure checklist and lower the landing gear were initially reported as the probable cause.

July 17, 1996, East Moriches, New York, Trans World Airlines. The aircraft exploded at flight level 130, broke up and crashed into the Atlantic Ocean. All 230 persons on board died.

February 14, 1997, Carajas, Brazil, Varig. The aircraft crashed on its landing to Carajas Airport. The first officer was the only fatality.

August 06, 1997, Guam, Guam, Korean Air. The aircraft crashed on Nimtiz Hill in Guam while on approach to the airport. 228 persons on board died, 26 survived. The probable cause of the accident was the pilot's poor execution of the landing. The pilot's fatigue and Korean Air's lack of flight crew training appear to have been a contributing factor.

September 06, 1997, Beijing, China, Canadian. The flight rejected takeoff after experiencing an engine fire. 199 passengers on board were safely evacuated but the aircraft was substantially damaged.

October 10, 1997, Nuevo Berlin, Uruguay, Austral Lineas Aereas. The aircraft carrying 74 persons crashed near Nuevo Berlin after changing its route to escape heavy rain. All persons on board died.
October 15, 1997, Mexico City, Mexico, Aeroméxico. The aircraft carrying 72 persons ran out of runway while landing. No fatalities occurred but the aircraft was damaged beyond repair.
December 16, 1997, Fredericton, Canada, Air Canada. The aircraft ran out of runway while landing. No fatalities occurred but the aircraft was damaged beyond repair. The first officer's lack of experience and training in flying this type of aircraft in low-visibility conditions led to the faulty landing.
December 28, 1997, Over the Pacific Ocean, United Airlines. The aircraft carrying 369 persons from Tokyo to Honolulu suffered clear air turbulence while cruising over Pacific Ocean. The plane made a return and landed safely in Tokyo, but one passenger was killed. The aircraft was damaged beyond repair.
January 11, 1998, Samsun, Turkey, Turkish Airlines. The plane carrying 74 persons crashed while trying to land at Samsun Airport. No fatalities occurred but the aircraft was damaged beyond repair.
February 09, 1998, Chicago, Illinois, American Airlines. The plane hit the runway due to the failure of the flight crew to maintain a proper pitch attitude for a successful landing. No fatalities occurred but the aircraft was damaged beyond repair.
April 20, 1998, Near Bogota, Colombia, Air France. The aircraft crashed into Mountain Cerro el Cable and burst into flames. All 53 persons on board died.
August 05, 1998, Seoul, South Korea, Korean Air. The airplane carrying 395 persons on board overran the side of the runway on landing. No fatalities occurred but the aircraft was damaged beyond repair.
September 02, 1998, Nova Scotia, Canada, Swissair. The plane carrying 229 people on board crashed into the waters off Peggy's Cove with no survivors.
September 16, 1998, Guadalajara, Mexico, Continental Airlines. The aircraft with 108 persons on board was substantially damaged following a loss of control during the landing. No fatalities occurred but the aircraft was damaged beyond repair.
October 07, 1998, Miami, Florida, Continental Airlines. The aircraft carrying 81 people on board aborted its takeoff and overran the runway. No fatalities occurred but the aircraft was damaged beyond repair.
October 25, 1998, San Juan, Puerto Rico, American Eagle Airlines. The plane crashed on landing in San Juan after a propeller struck a truck, an engine fell off and caught fire. No fatalities occurred but the aircraft was damaged beyond repair.
November 01, 1998, Atlanta, Georgia, AirTran Airways. The aircraft with 105 persons on board lost control and skidded off the runway while landing. No fatalities occurred but the aircraft was damaged beyond repair.
December 11, 1998, Near Surat Thani, Thailand, Thai Airways. The plane with 146 people on board crashed on approaching the Surat Thani Airport. 102 persons on board died, 44 survived.
December 28, 1998, Curitiba, Brazil, Rio Sul. The aircraft landed at a very high speed, resulting in the crack of its tail section. No fatalities occurred but the aircraft was damaged beyond repair.
January 28, 1999, Catania, Italy, Alitalia. The aircraft experienced an unstabilized landing and the left main gear collapsed. There were no fatalities among the 84 people on board but the aircraft was damaged beyond repair.
February 25, 1999, Genoa, Italy, Alitalia. The flight with 31 people on board overshot the runway and ran into the Mediterranean. 4 people on board died and the fuselage of the plane sank.
March 04, 1999, Biarritz Parme, France, Air France. The aircraft slid off the side of the runway while landing. There were no fatalities among the 97 people but the aircraft was damaged beyond repair.
March 15, 1999, Pohang, South Korea, Korean Air. The plane carrying 159 persons overran the runway while landing to Pohang Airport. No fatalities occurred but the aircraft was damaged beyond repair.
June 01, 1999, Little Rock, Arkansas, American Airlines. 11 people on board died, 134 survived. The airplane over ran the runway during landing.
August 31, 1999, Buenos Aires, Argentina, Lineas Aereas Privadas Argentinas. 64 people on board died, 39 survived. The aircraft aborted its takeoff, skidded off the runway and exploded into flames at Jorge Newberry airport.

September 09, 1999, Nashville, Tennessee, Trans World Airlines. The aircraft suffered a landing gear collapse after a hard touchdown. All 46 passengers and crew survived.
December 11, 1999, Sao Jorge, Azores, SATA. The aircraft carrying 35 people crashed on the island of Sao Jorge with no survivors.
January 30, 2000, Off Abidjan, Ivory Coast, Kenya Airways. The aircraft carrying 179 people crashed into the Atlantic Ocean shortly after taking off from Felix Airport. 169 people on board died, 10 survived.
January 31, 2000, Off Point Mugu, California, Alaska Airlines. The aircraft carrying 88 people crashed into the Pacific Ocean while en route from Puerto Vallarta to San Francisco with no survivors.
March 15, 2000, Kuala Lumpur, Malaysia, Malaysia Airlines. The aircraft was damaged by the leakage of a type of harmful chemical that was different from the product that had been declared at the customs clearance at the Kuala Lumpur International Airport. There were no fatalities among 266 people on board but the aircraft was considered damaged beyond repair.
March 21, 2000, Killeen, Texas, American Eagle Airlines. The aircraft with 36 people on board sustained substantial damage after a runway overrun during the landing. No fatalities occurred.
April 22, 2000, Siirt, Turkey, Turkish Airlines. The airplane over ran the runway during landing. No fatality among 46 people on board but the aircraft was considered damaged beyond repair.
25 July, 2000, Gonesse, France, Air France. The plane plummeted into a hotel in Gonesse. All 100 passengers and 9 crew members on board the flight died.
August 08, 2000, Greensboro, North Carolina, *AirTran Airways.* The aircraft caught fire shortly after the takeoff from Greensboro Airport. All passengers were safely evacuated but the airplane was substantially damaged beyond repair.
October 06, 2000, Reynosa, Mexico, Aeromexico. The aircraft crashed into a ditch after an uncontrolled landing. All 88 people on board survived.
October 31, 2000, Taipei, Taiwan, Singapore Airlines. 83 people on board died, 96 survived. The aircraft crashed on a wrong runway during takeoff.
November 20, 2000, Miami, Florida, American Airlines. The airplane experienced the decrease of cabin pressure due to the failure of the bleed air system. One crew member died during the emergency evacuation.
November 29, 2000, Atlanta, GA, AirTran Airways. The flight crew performed an emergency landing in Atlanta because of smoke leaking from the airplane. No fatalities occurred but the airplane sustained substantial damage and was written off.
February 07, 2001, Bilbao, Spain, Iberia. The plane's nose gear collapsed after landing and overrunning the runway. There were no fatalities among the 143 people on board but the aircraft was considered damaged beyond repair.
March 17, 2001, Detroit, Michigan, Northwest Airlines. The Airbus A320 skidded off the runway after an aborted takeoff. There were no fatalities among the 151 people on board but the aircraft was considered damaged beyond repair.
May 23, 2001, Dallas, Texas, American Airlines. The pilot's failure to maintain directional control and stop the aircraft by the end of the runway caused the crash. There were no fatalities among the 92 people on board but the aircraft was written off.
September 16, 2001, Goiania, Brazil, Varig. The aircraft with 67 people on board crashed into the ground during its landing approach. No fatalities occurred but the aircraft was considered damaged beyond repair.
October 17, 2001, Dubai, United Arab Emirates, Pakistan International Airlines. The aircraft suffered a landing gear failure upon landing at Dubai International Airport. No fatalities occurred among the 205 people on board but the aircraft was considered damaged beyond repair.
November 12, 2001, Belle Harbor, New York, American Airlines. The flight carrying 265 people crashed shortly after takeoff from JFK airport. There were no fatalities.
January 28, 2002, Near Ipiales, Colombia, TAME. The airliner crashed while on approach to Tulcan airport, killing all 92 people on board. The pilot's lack of experience in dealing with bad weathers condition is a likely cause of the accident.

July 10 2002, Werneuchen, Germany, Swiss. The aircraft with 20 people on board crashed into the ground during its landing approach. There were no fatalities but the aircraft was considered damaged beyond repair.
August 28, 2002, Phoenix, Arizona, American West. The aircraft overran the runway during its landing because of the pilot's failure to maintain directional control. All 159 people survived but the aircraft was considered damaged beyond repair.
October 31, 2002, Monterrey, Mexico, Aeroméxico. The aircraft overran the runway at Monterrey City while attempting to land. All 90 people on board survived but the aircraft sustained serious damage.
January 08, 2003, Diyarbakir, Turkey, Turkish Airlines. 75 people on board died, 5 survived. The aircraft crashed into the ground during its final approach to landing.
January 17, 2003, Quito-Mariscal, Ecuador, TAME. The aircraft ran off the runway after an aborted takeoff. There were no fatalities but the aircraft was damaged beyond repair.
January 17, 2003, Melilla, Spain, Air Nostrum. The aircraft overran the runway at Melilla Airport and crashed into the guardrail resulting in the aircraft broking apart. There were no fatalities but the aircraft was damaged beyond repair.
March 01, 2004, Jeddah, Saudi Arabia, Pakistan International Airlines. The aircraft crashed into the ground and caught fire after an aborted takeoff. All 261 passengers and 12 crew survived
April 20, 2004, Trieste, Italy, Alitalia. While taxing on the airport, the aircraft collided with a truck parked nearby. There were no fatalities but the aircraft was substantially damaged and written off.
May 09, 2004, San Juan, Puerto Rico, American Eagle Airlines. The aircraft bounced on landing resulting in a crash. No fatalities occurred. The National Transportation Safety Board concluded that the accident was attributed to the pilot's failure to follow proper techniques to recover from the bounced landings and his subsequent faulty execution of go around.
June 16, 2004, Chitral, Pakistan, Pakistan International Airlines. The aircraft failed to stop within the length of the runway and crashed into a drainage ditch. All 40 people on board survived but the aircraft was substantially damaged and written off.
November 28, 2004, Barcelona, Spain, KLM Royal Dutch Airlines. The aircraft skidded off the runway during landing. No injuries were reported but the aircraft was substantially damaged beyond repair.
May 10, 2005, Minneapolis, Minnesota, Northwest Airlines. The DC-9 collided with an Airbus A-319 during taxiing leading to substantial damage to both airplanes. Both airplanes were operated by Northwest Airlines. No fatalities occurred among the 99 people on board.
August 02, 2005, Toronto, Canada, Air France. The aircraft failed to stop before reaching the end of the runway. It broke in two and caught fire. All 309 occupants were able to evacuate but the aircraft was substantially damaged and written off.
August 19, 2005, Guam, Guam, Northwest Airlines. On landing at Guam airport, the nose gear collapsed, and the aircraft slid off the runway. All occupants escaped but the aircraft was damaged beyond repair.
March 11, 2006, Bangalore, India, Air Deccan. The aircraft suffered a hard landing at Bangalore Airport and ran off the runway. All the passengers and crew were safely evacuated but the aircraft was substantially damaged.
July 10, 2006, Multan, Pakistan, Pakistan International Airlines. The plane crashed into a wheat field during takeoff and burst into flames. All 45 occupants died, none survived.
August 27, 2006, Lexington, Kentucky, Comair. The plane crashed during takeoff from Blue Grass Airport. 49 people on board died, one survived.
September 29, 2006, Near Sao Felix do Araguaia, Brazil, Gol Airlines. The plane with 155 people on board disappeared over the Amazon jungle after colliding with an Embraer ERJ-135 business jet.
March 14, 2007, Kochi, Japan, All Nippon Airways. The plane crashed into an open field fifteen minutes before reaching its destination. There were no fatalities among the 60 occupants but the aircraft was damaged beyond repair.
May 05, 2007, Near Dizangue, Cameroon, Kenya Airways. The plane crashed into a forested area shortly after taking off from Douala Airport. All 114 occupants died.

July 01, 2007, Indore, India, Jet Airways. The flight skidded off the runway while landing at the Indore Airport. There were no fatalities among the 49 occupants but the aircraft was damaged beyond repair.
July 16, 2007, Sao Paulo, Brazil, Pantanal. The aircraft veered off the runway while approaching Congonhas Airport. 25 occupants were safely evacuated.
November 09, 2007, Quito, Ecuador, Iberia. The aircraft overran the runway while approaching landing at Quito. All 395 occupants were safely evacuated.
January 17, 2008, London, England, British Airways. While approaching landing at Heathrow Airport, the aircraft suddenly descended rapidly and then crashed into the ground. There were no fatalities among the 152 occupants but the aircraft was damaged beyond repair.
July 31, 2008, Wien, Austria, Iberia. The nose gear collapsed during the hard landing, generating a shower of sparks. There were no fatalities but the aircraft was seriously damaged.
August 20, 2008, Madrid, Spain, Spanair. The plane with 172 people on board crashed while attempting to take off from Barajas Airport. 154 people on board died, 18 survived.
December 20, 2008, Denver, Colorado, Continental Airlines. The aircraft slid off the runway during a night takeoff and went into a ravine, where it caught fire. All 110 passengers and five crew members managed to escape.
January 15, 2009, New York, New York, US Airways. The plane began to lose altitude shortly after its takeoff from La Guardia Airport. The flight crew completed an emergency landing in the Hudson River. All 155 persons on board safely evacuated before the plane began to sink.
February 25, 2009, Amsterdam, Netherlands, Turkish Airlines. The plane carrying 134 people crashed into the ground during its landing approach and broke into three. 9 people on board were killed, 125 people survived.
June 01, 2009, Atlantic Ocean, Air France. The Airbus carrying 228 people went missing over the Atlantic Ocean on a flight from Rio de Janeiro to Paris, France.
September 04, 2009, Mumbai, India, Air India. While attempting to takeoff, fuel leaking from the wings resulted in the aircraft catching fire. All passengers and crew were evacuated through the escape chutes.
December 22, 2009, Kingston, Jamaica, American Airlines. The plane, carrying 154 people on board, overran the runway upon landing. It went through the airport perimeter, across streets and eventually came to a stop after colliding with rocks on the beach. No fatalities occurred but the aircraft was damaged beyond repair.